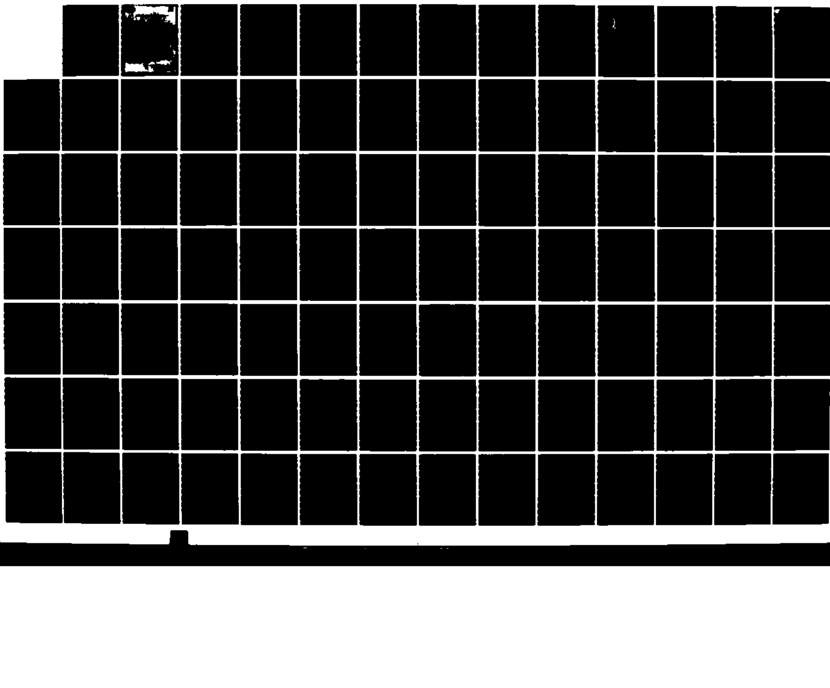
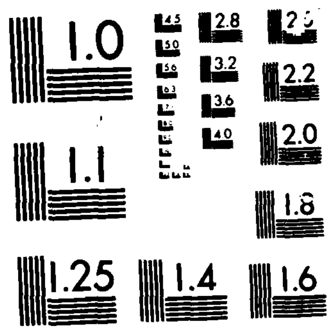
AD-A165 615 MISCELLANEOUS STRUCTURES EAST COAST AIR COMBAT MANEUVERING RANGE OFFSHORE..(U) CREST ENGINEERING INC TULSA OK SEP 76 27-771-98 CHES/NAVFAC-FPO-7626 1/1

UNCLASSIFIED N62477-76-C-0179 F/G 13/13 NL






MICROCOPY RESOLUTION TEST CHART

(1)

# MISCELLANEOUS STRUCTURES

EAST COAST AIR COMBAT MANEUVERING RANGE
OFFSHORE KITTY HAWK, NORTH CAROLINA
CONTRACT NO. N62477-76-C-0179
MODIFICATION NO. P0001

REPORT NO. 29[illegible]

PREPARED FOR
NAVAL FACILITIES ENGINEERING COMMAND
DEPARTMENT OF THE NAVY
CHESAPEAKE DIVISION



BY

CREST ENGINEERING, INC.
TULSA, OKLAHOMA

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

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Approved for public release; distribution is unlimited

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Report No. 27-771-98

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FPO 7626

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Crest Engineering

6b. OFFICE SYM

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Project Office
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6c. ADDRESS (City, State, and Zip Code)
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Miscellaneous Structures East Coast Air Combat Maneuvering Range Offshore Kitty Hawk, North Carolina

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This report contains design calculations relative to the superstructues and structural appurtenances for the four tripod-type ocean structures for the East Coast Air Combat Maneuvering Range offshore Kitty Hawk, North Carolina.

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Issue



# MISCELLANEOUS STRUCTURES
# EAST COAST AIR COMBAT MANEUVERING RANGE
# OFFSHORE KITTY HAWK, NORTH CAROLINA

CONTRACT NO. N62477-76-C-0179
MODIFICATION NO. P0001

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Prepared for

NAVY FACILITIES ENGINEERING COMMAND
DEPARTMENT OF THE NAVY
CHESAPEAKE DIVISION

By

CREST ENGINEERING, INC.
TULSA, OKLAHOMA

September 1976

TABLE OF CONTENTS

# SECTION 1

# INTRODUCTION

## 1.1 INTRODUCTION

This report contains design calculations relative to the superstructures and structural appurtenances for the four tripod-type ocean structures for the East Coast Air Combat Maneuvering Range offshore Kitty Hawk, North Carolina.

## 1.2 DESIGN CRITERIA

The criteria employed to design each component of the structure are listed as follows:

(a) Superstructure:

| | | |
|---|---|---|
| Live Loads: | Upper Deck | 100 psf |
| | Equipment Deck | 150 psf |
| | Stairway | 100 psf |
| Material: | A36 Structural Steel | |

(b) Boat Landing:

Design Loads: 4,000 lbs. concentrated load or equivalent uniform load.

Minimum Plan Dimensions: 4 ft. x 6 ft.

(c) Equipment Supports:

Wind Load: 150 knots at EL(+) 30'-0"

## 1.3 DESIGN SUMMARY

Pertinent information relative to the superstructure and boat landing are listed as follows:

<u>Superstructure</u>:

| | |
|---|---|
| Equipment Deck Area | 591.5 sq. ft. |
| Upper Deck Area | 362.5 sq. ft. |
| Structural Steel Weight (including stairways, handrails, and kick plate) | 113.5 kips |
| Paint Area | 8,500.0 sq. ft. |

<u>Boat Landing</u>:

| | |
|---|---|
| Overal Dimensions | 22 ft. x 12 ft. x 4 ft. |
| Structural Steel Weight | 22.0 kips |
| Paint Area | 1,115.7 sq. ft. |

## 1.4 PERSONNEL RESUMES

The personnel whose resumes follow were actively engaged in this project.

CREST OFFSHORE, INC.

Chingmiin (Charlie) Chern

Senior Engineer

| University | Degree | Year |
| --- | --- | --- |
| National Taiwan University | Bachelor of Science Civil Engineering | 1961 |
| North Dakota State University | Master of Science Civil Engineering | 1966 |
| Lehigh University | Ph. D. Civil Engineering | 1969 |
| Tulsa University | Graduate Study in Business Administration-Management | 1974 |

Societies, Licenses, and Other Activities:

Member American Society of Civil Engineers
Member International Association of Structural and Bridge Engineers
Member American Society of Engineering Education
Registered Professional Engineer in Oklahoma

Experience:

1973 to Present — Crest Offshore, Inc.

Senior Civil Engineer

Engaged in the feasibility studies, structural analysis and design of offshore structures, equipment supports and other various types of petroleum related civil engineering works. Assignments include:

... Evaluation of engineering designs from other agencies.
... Analysis and design of offshore structures for oil industry.
... Analysis and design of supports and foundations for onshore refinery facilities.
... Development of a sequence of computer programs for the analysis of offshore structures.

CREST OFFSHORE, INC.

Chingmiin (Charlie) Chern

Senior Civil Engineer

Experience Continued:

| | |
|---|---|
| 1969 to 1973 | North Dakota State University |
| Associate Professor of Civil Engineering | Engaged in full-time lecture instruction for civil engineering (graduate school division) and construction management. Also served as consultant to local industry (undergraduate school division) in the area of computer applications in engineering. |
| 1966 to 1969 | Fritz Engineering Laboratory |
| Research Assistant | Assisted in the design and testing of various types of steel structures. |
| 1966 | North Dakota State Highway Department |
| Highway Engineer | Responsible for construction surveying. |
| 1965 | U.S. Forest Service |
| Assistant Crew Chief | Assisted in surveying responsibilities. |

# SECTION 2

# SUPERSTRUCTURES

## 2.1 INTRODUCTION

Set forth hereinafter are the design calculations for the superstructure which is common to each platform. Structural steel weights and the surface area to be painted are also tabulated.

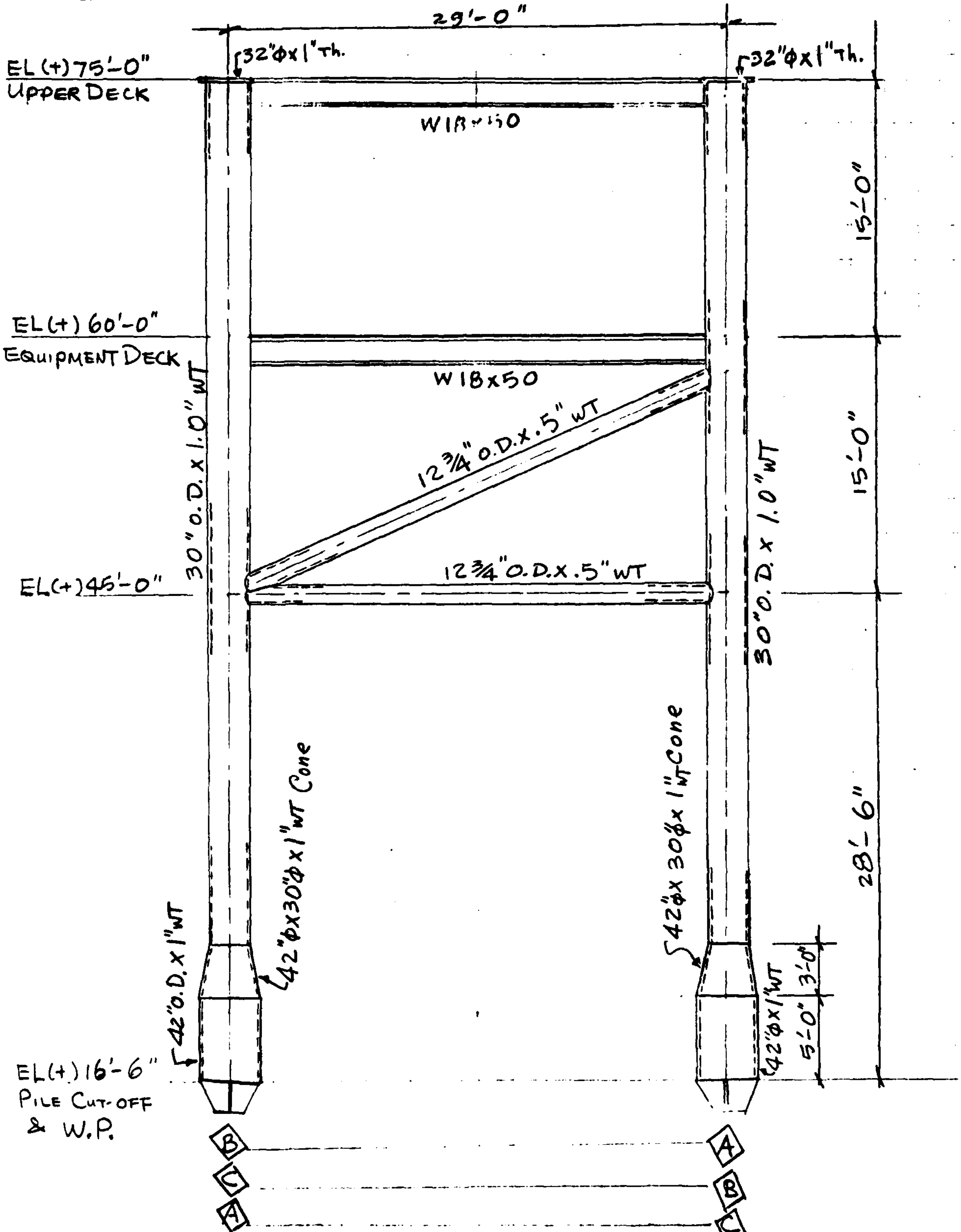
**CREST OFFSHORE, INC.**

Sheet 2-02 of ____

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 6-10-76 Job No. 27-771-98 Calculation Superstructures (Elevation)

## 2.2 ELEVATION

Scale 1/8" = 1'-0"



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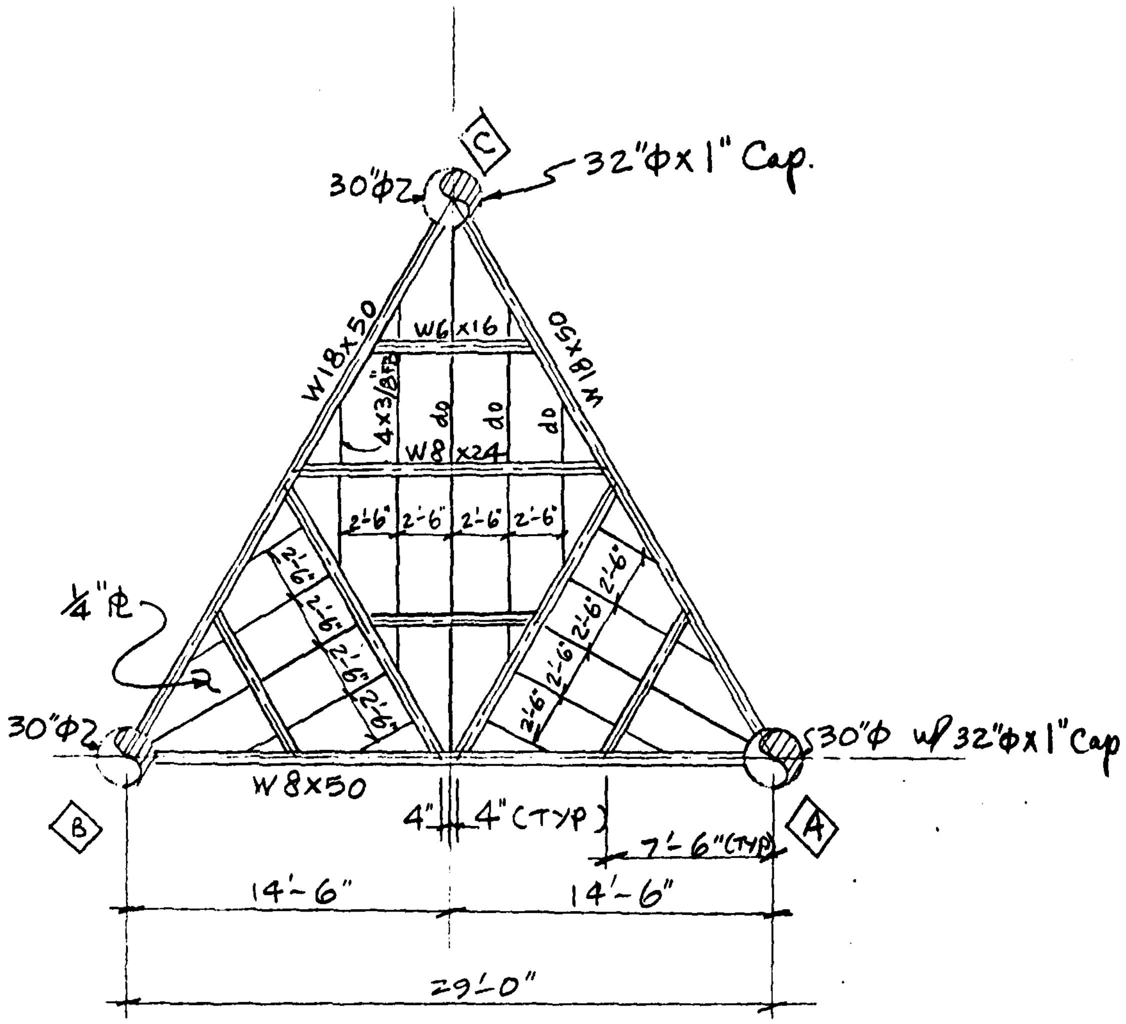
Sheet 2-03 of ____

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 6-10-76 Job No. 27-771-98 Calculation Superstructures (Upper Deck)

## 2.3 UPPER DECK

Design Live Loads = 100 psf

Scale 1/8" = 1'-0"



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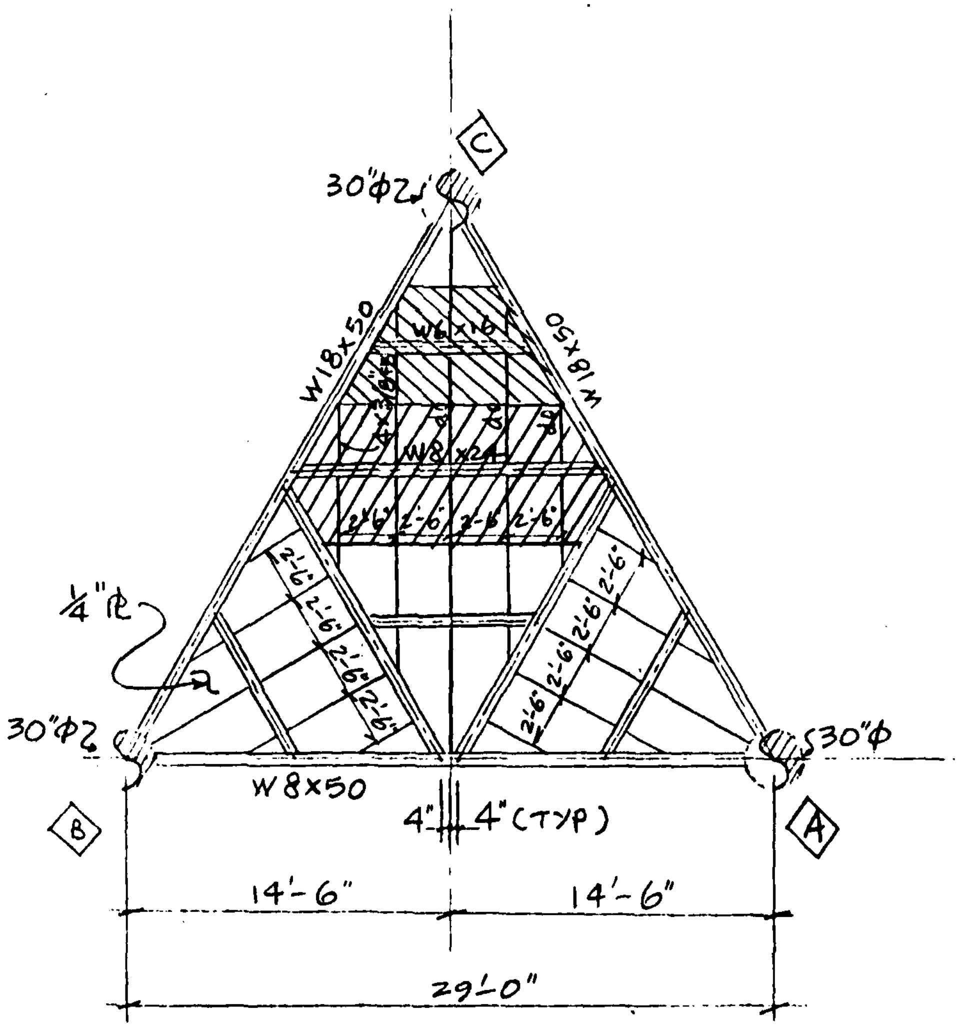
Sheet 2.04 of ____

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 6-10-76 Job No. 27-771-98 Calculation Superstructures (Upper Deck)

Design Live Loads = 100 psf

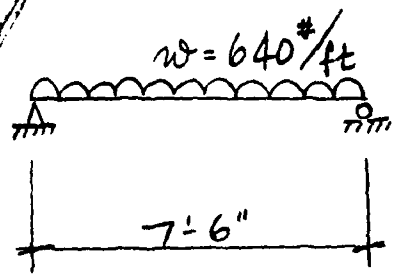
Scale 1/8" = 1'-0"



4 x 3/8 Flat Bars

See Page 9.22
Report on Structural Concept Analysis
Appendix C — 3-pile Structure

W6x15.5




Tributary Area = 7.5' x 5.5' = 41.25 □'

Uniform Loads:

| | | |
|---|---|---|
| 1/4" ℞ | 10.2 x 41.25 = | 420.75# |
| L.L. | 100 x 41.25 = | 4,125.00# |
| | | 4,545.75# |

Bm. Wt.:

| | | |
|---|---|---|
| W6x15.5 | 15.5 x 7.5 = | 116.25# |
| 4" x 3/8" F.B. | $6 \times 5.10 \times \frac{5.5}{2}$ = | 84.15# |
| | | 200.40# |

Total Weight = 4,746.15#

Equivalent uniform load = 632.82 #/ft

Say 640 #/ft

$$M_{max} = \frac{1}{8} w l^2 = \frac{1}{8} \times 640 \times (7.5)^2 \times \frac{12}{1000} = 54 \text{ "K}$$

Use W6x15.5 $S = 10.0 \text{ in}^3$

$$\sigma_t = \frac{54}{10.0} = 5.4 \text{ ksi} \qquad \text{O.K.}$$

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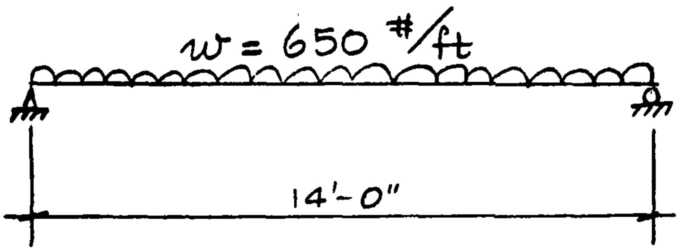
Sheet 2.06 of ____

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 6-10-76 Job No. 27-771-98 Calculation Superstructures (Upper Deck)

W 8x24




Tributary Area = 12 x 6.5 = 78 □'

Uniform Loads:

| | | |
|---|---|---|
| 1/4" ℞ | 10.2 x 78 | = 795.6 # |
| L.L. | 100 x 78 | = 7,800.0 # |
| | | 8,595.6 # |

Beam Wt.:

| | | |
|---|---|---|
| W8x24 | 24 x 14 | = 336 # |
| 4x3/8" F.B. | $10 \times 5.1 \times \frac{5.5}{2}$ | = 140.3 # |
| | | 476.3 # |

Total Weight = 8,595.6 + 476.3 = 9,071.9 #

Equivalent uniform load = 648 #/ft

Say 650 #/ft

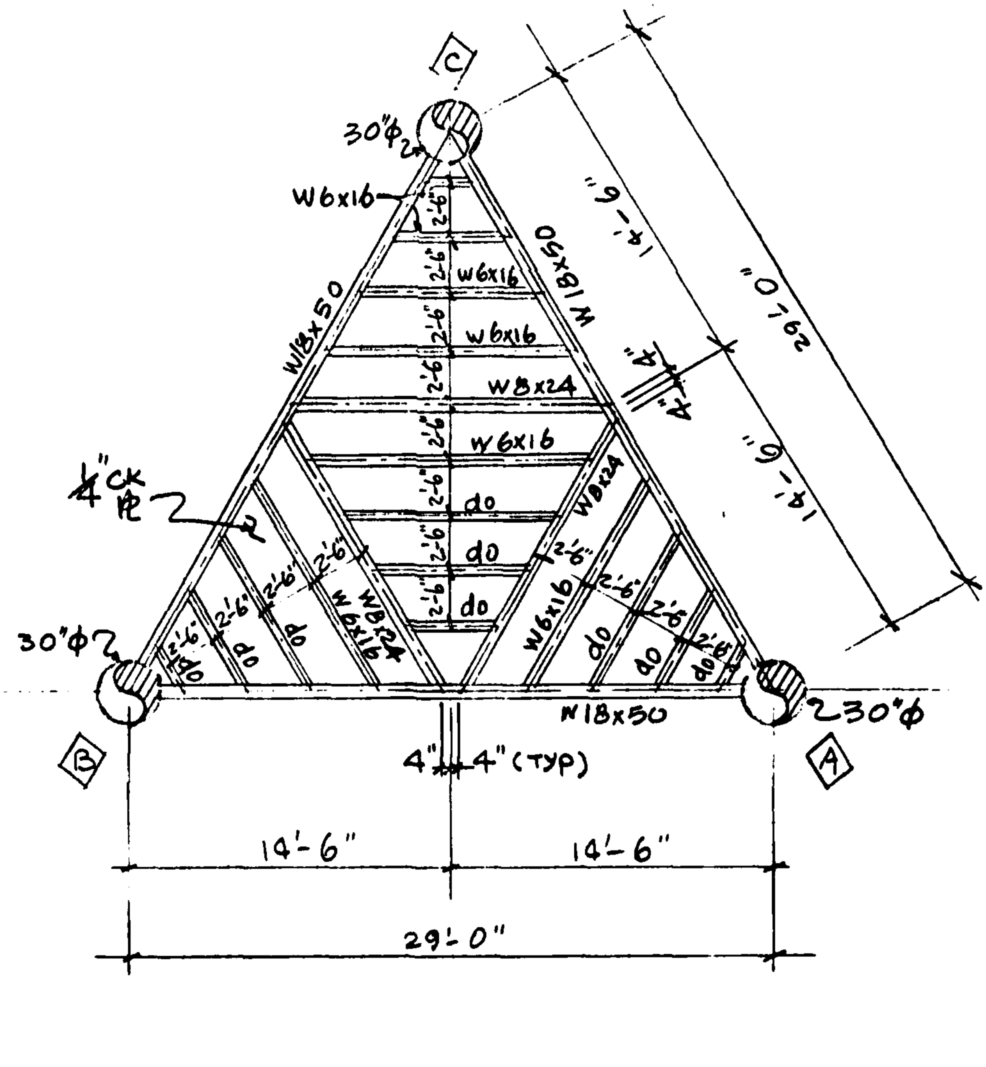
$$M_{max} = \frac{1}{8} \times 650 \times (14)^2 \times \frac{12}{1000} = 191.1 \text{ "-K}$$

Use W 8x24 $S = 20.8 \, in^3$ $\sigma_t = 9.2$ ksi o.K.

## 2.4 EQUIPMENT DECK

Design Live Loads = 150 psf

Scale 1/8" = 1'-0"



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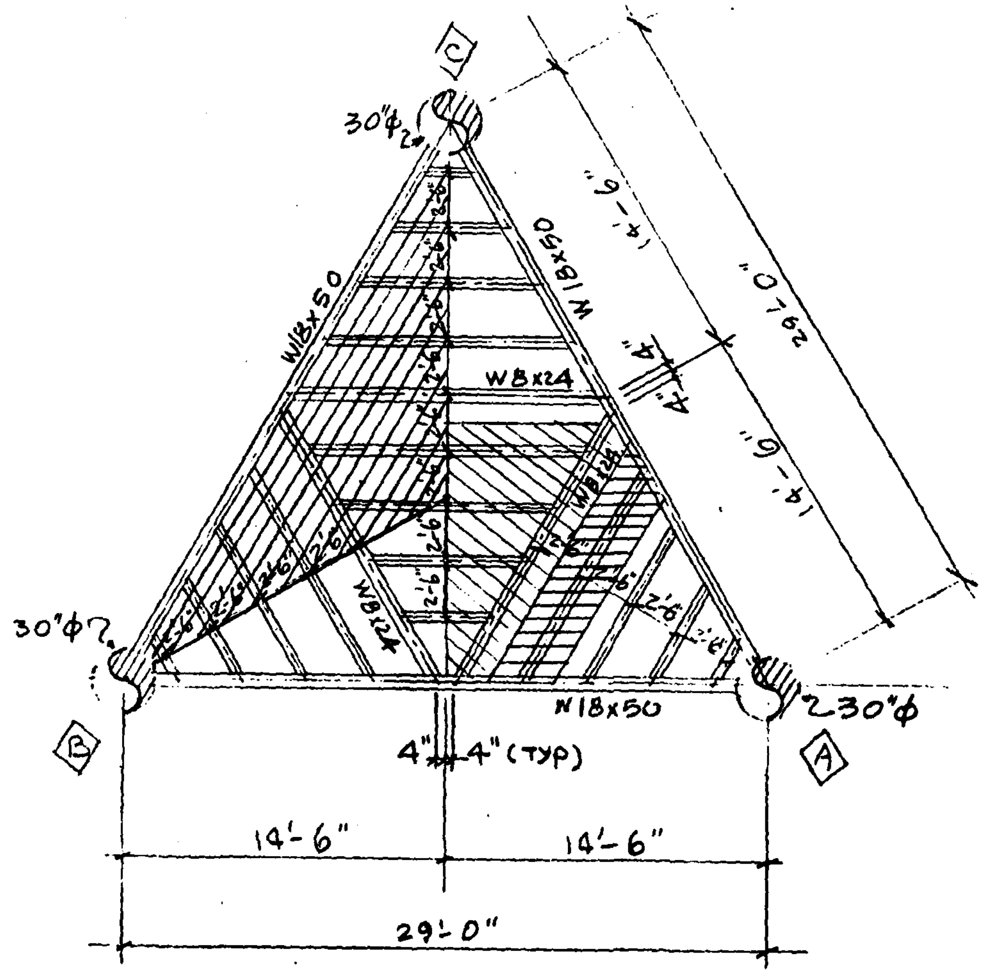
Sheet 2.08 of ____

By C. Chern  Client U.S. NAVY  Subject Miscellaneous Structures

Date 6-10-76  Job No. 27-771-98  Calculation Superstructures (Equipment Deck)

Design Live Loads = 150 psf

Scale 1/8" = 1'-0"



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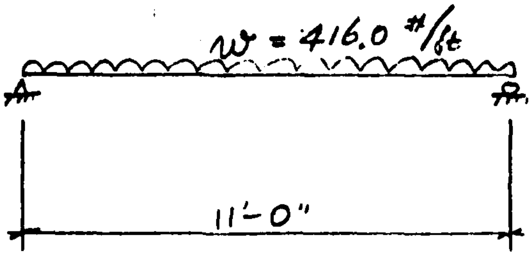
Sheet 2-09 of ----

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 6-10-76 Job No. 27-771-98 Calculation Superstructures (Equipment Deck)

## W 6x15.5




Tributary Area 2'-6" x 11'-0"

D.L.

1/4" PL 10.2 x 2.5 = 25.5 #/ft

Bm W6x15.5 15.5

41.0 #/ft

L.L. 150x2.5 = 375 #/ft

Total $w$ = 416.0 #/ft

$$M_{max} = \frac{1}{8} w l^2 = \frac{416.0 \times 11^2 \times 12}{8 \times 1000} = 75.5 \text{ in-k}$$

A36 Steel $\sigma_t = 22$ ksi

$$S = \frac{75.5}{22} = 3.43 \text{ in}^3$$

Use W 6x15.5 $S_x = 10.0 \text{ in}^3$

$$\sigma_t = \frac{75.5}{10.0} = 7.5 \text{ ksi}$$

AISC 2-48 Allowable load = 14.8 kips

> .416 x11 = 4.58 kips

AISC 2-95 Allowable moment = 19 FT-kips

= 228 in-k > 75.6 in-k

Use W6x16 for Min Thickness ≥ 1/4" (web)

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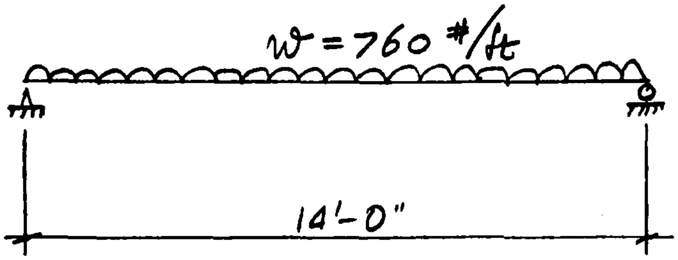
Sheet 2-10 of ____

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 6-10-76 Job No. 27-771-98 Calculation Superstructures (Equipment Deck)

W 8x24




Tributary Area $= 14' \times 1.25' + \frac{1}{2} \times 7.5' \times 12'$

$= 17.5 + 45$

$= 62.5$ SQ. FT

Uniform Loads: 1/4" PL  $10.2 \times 62.5 = 637.5$ #

L.L.  $150 \times 62.5 = 9{,}375.0$ #

10,012.5 #

Beam Wt. :

W8x24  $24 \times 14 = 336$ #

W 6x15.5  $15.5 \times (6.5 + 5 + 3.5 + 2) = 264$ #

600 #

Total Weight = 10,612.5 #

Equivalent uniform load = 758.0 #/ft

Say 760 #/ft

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By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 6-10-76 Job No. 27-721-98 Calculation Superstructures (Equipment Deck)

$$M_{max} = \frac{1}{8} w l^2 = \frac{1}{8} \times 760 \times 14^2 \times \frac{12}{1000} = 223.44 \text{ ''-K}$$

A36 Steel $\sigma_t = 22$ ksi

$$S = \frac{223.44}{22} = 10.2 \text{ in}^3$$

Use W8x24 $S = 20.8 \text{ in}^3$

$$\sigma_t = \frac{223.44}{20.8} = 10.74 \text{ ksi}$$

AISC 2-47 Allowable Load = 23.8 kips
$> 10.6$ kips

AISC 2-95 Allowable moment = 38 FT-KIPS
= 456 ''-kips $>$ 223.44 ''-K

O.K.

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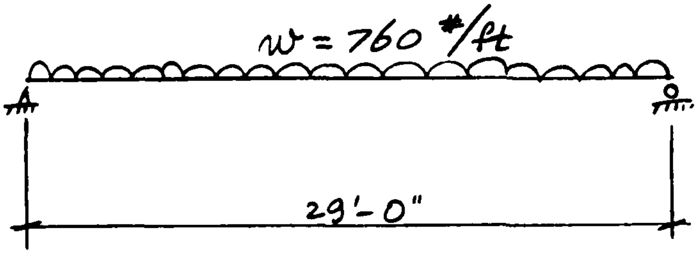
Sheet 2-12 of ____

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures

Date 6-10-76 Job No. 27-221-98 Calculation Superstructures (Equipment Deck)

<u>W 18x50</u>




Tributary Area $= \frac{1}{2} \times 29' \times (\frac{1}{3} \times 25') = 120.83$ SQ. FT

Uniform Loads:

| | | |
|---|---|---|
| 1/4" ℘ | 10.2 x 120.83 | = 1,232.5 # |
| L.L. | 150 x 120.83 | = 18,124.5 # |
| | | 19,357.0 # |

Beam Wt.

| | | |
|---|---|---|
| W 18x50 | 29x 50 | = 1,450 # |
| W 8x24 | 24x ( 7 + 7 ) | = 336 # |
| W 6x15.5 | 15.5x (6.5+5+3.5+2)x 3 | = 791 # |
| | | 2,577 # |

Total Wt. = 19,357 + 2,577 = 21,934 #

Equivalent uniform load = 756.3 #/ft

Say 760 #/ft

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Sheet 2.13 of ____

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 6-10-76 Job No. 27-771-98 Calculation Superstructures (Equipment Deck)

$$M_{max} = \frac{1}{8} w l^2 = \frac{1}{8} \times 760 \times (29)^2 \times \frac{12}{1000} = 958.74 ''^k$$

A36 Steel $\sigma_t = 22$ ksi

$$S = \frac{958.74}{22} = 43.6 \text{ in}^3$$

Use W18x50 $S = 89.1$ in³

$$\sigma_t = \frac{958.74}{89.1} = 10.8 \text{ ksi}$$

AISC 2-38 Allowable Loads = 49 kips

> 22 kips

AISC 2-93 Unbracing length = 3'-0"

Allowable moment = 178 ft-kip

= 2,136 "-kips

> 958.74"K

o.k.

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Sheet 2.14 of ____

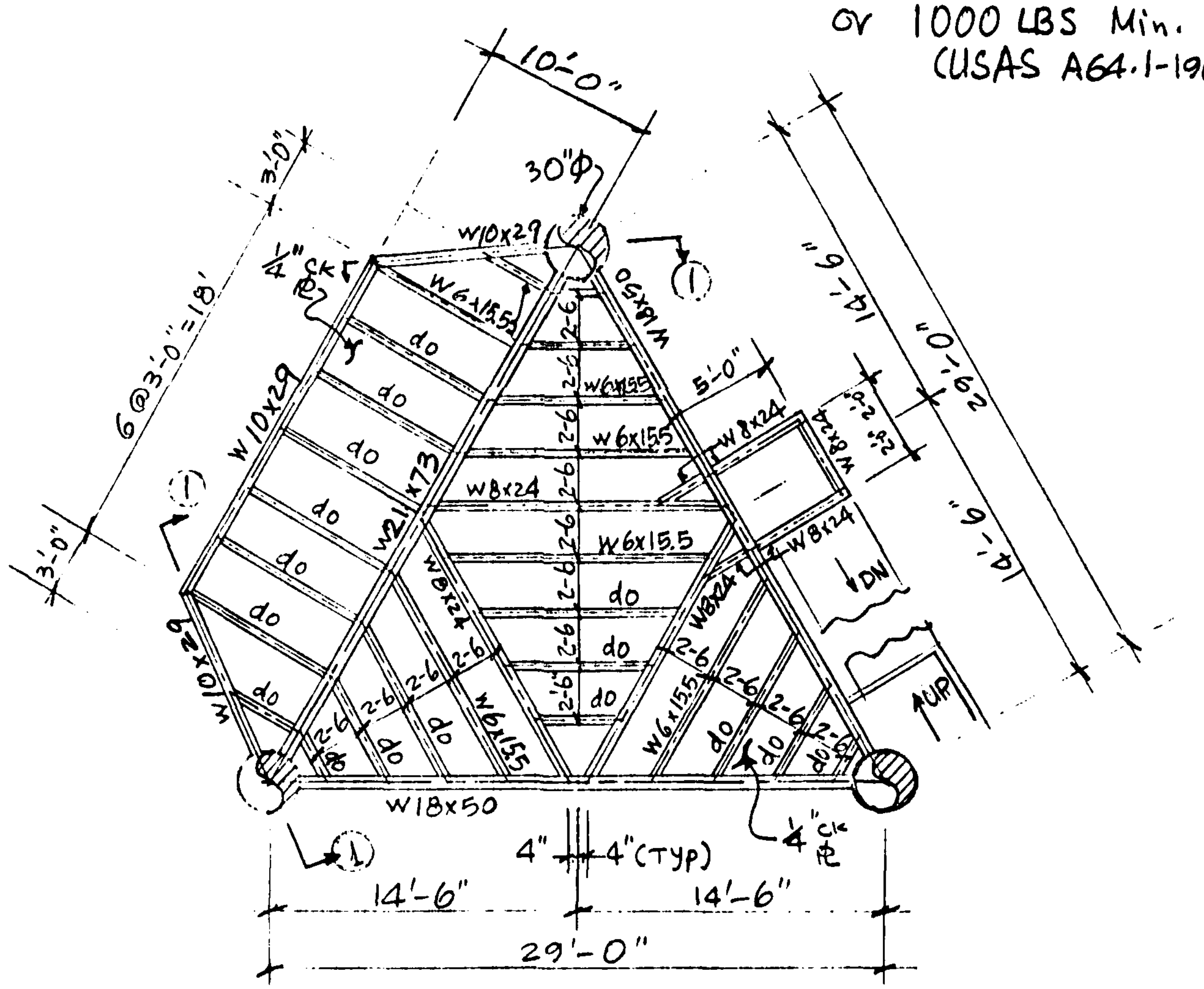
By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-2-76 Job No. 27-721-98 Calculation Superstructures (Equipment Deck)

## ADDITION OF DECK SPACE FOR SOLAR PANEL

Design Live Loads on Deck = 150 psf

Design Live Loads on Stairs = 100 psf (AISC)

or 1000 LBS Min.
(USAS A64.1-1968)



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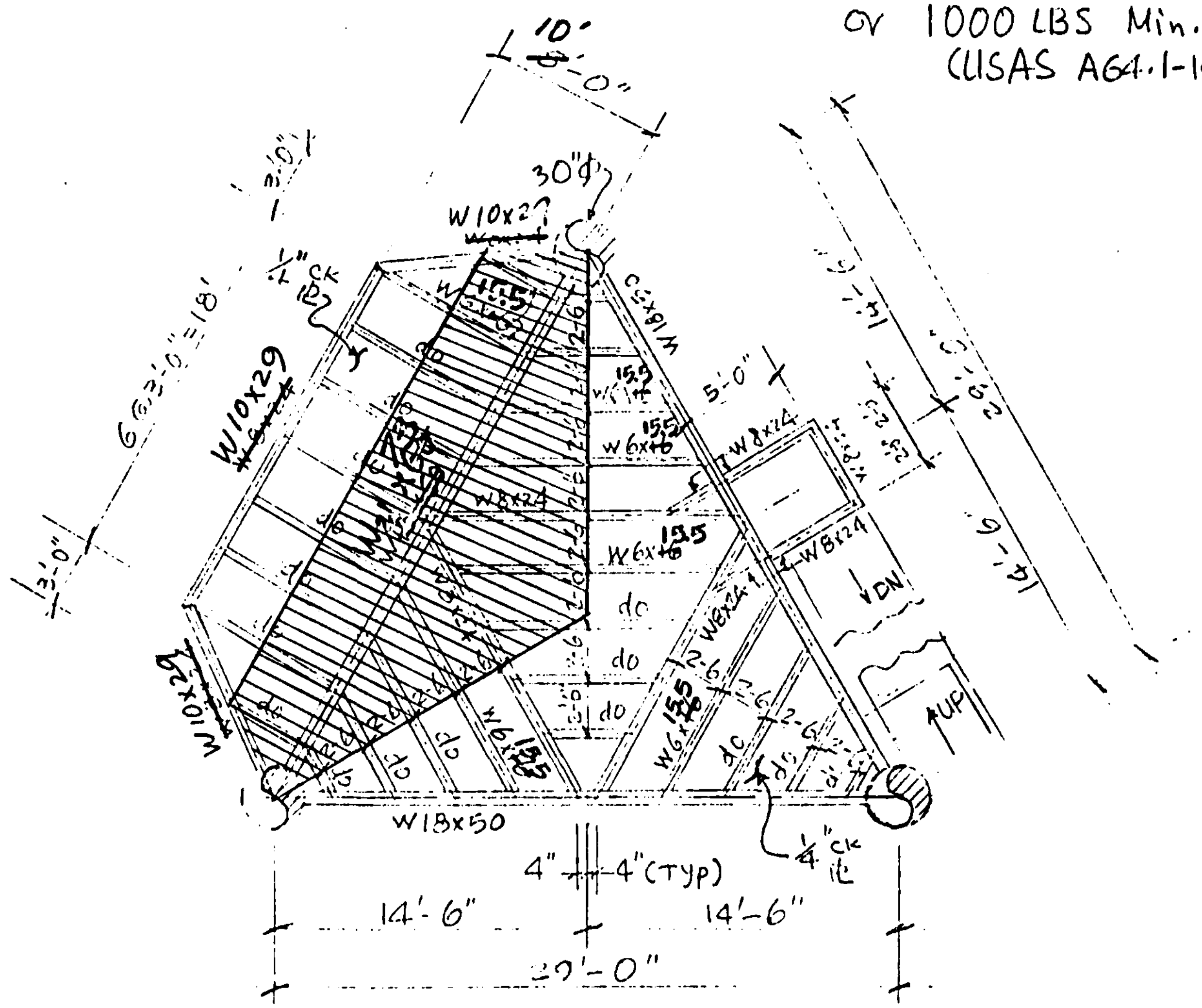
Sheet 2.1 of ____

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-2-76 Job No. 27-771-98 Calculation Superstructures (Equipment Deck)

Design Live Loads on Deck = 150 psf

Design Live Loads on Stairs = 100 psf (AISC)

or 1000 LBS Min.
(USAS A64.1-1968)



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Sheet 2-16 of ____

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-2-76 Job No. 22-771-98 Calculation Superstructures (Equipment Deck)
8-9-76 (updated)

## Check W21x73 Beam

Tributary Area $\frac{1}{2} \times 29' \times (\frac{1}{3} \times 25') = 120.83$ SQ.FT

$\frac{1}{2}(24' + 29') \times 5' = 132.50$ SQ.FT

253.33 SQ.FT

Uniform Loads:

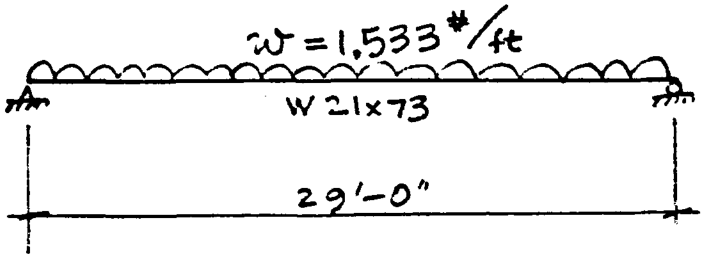
| | | |
|---|---|---|
| 1/4" PL | 10.2 x 253.33 | = 2,584.0 # |
| L.L. | 150 x 253.33 | = 38,000.0 # |
| | | 40,584.0 # |

Beam Wt:

| | | |
|---|---|---|
| W21x73 | 29 x 73 | = 2,117 # |
| W8x24 | 24 x (7+7) | = 336 # |
| W6x15.5 | 15.5 x (6.5+5+3.5+2) x 3 | = 791 # |
| W6x15.5 | 15.5 x 4 x 10 | = 620 # |
| | | 3,864 # |

Total Weight $W = 40,584.0 + 3,864.0$
$= 44,448$ #

Equivalent uniform load $w = 1,533$ #/ft




$$M_{max} = \frac{1}{8} \times \left(\frac{1.533}{1000}\right) \times 29^2 \times 12 = 1,933.9\ ^{"K}$$

Try W21x73 $\quad S_x = 151\ in^3 \quad ; \quad I_x = 1600$

$$\sigma_t = \frac{1,933.9}{151} = 12.8\ ksi < 22^{ksi}$$

o.k.

Max. deflection at center $\delta_c = \dfrac{5wl^4}{384EI}$

$$\delta_c = \frac{5 \times 1.533 \times 29^4 \times 12^3}{384 \times 30,000 \times 1600} = 0.51'' < 0.967''$$

o.k.

AISC $\quad \delta_{max} = \dfrac{l}{360} = \dfrac{29 \times 12}{360} = 0.967''$

**CREST OFFSHORE, INC.**

Sheet 2-18 of ____

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-2-76 Job No. 27-221-98 Calculation Superstructures (Equipment Deck)

Check ~~W 8x24~~ W10x29 @ 18'-0" Span

Tributary Area = 5x21 = 105 SQ.FT

1/4" PL 10.2 x 84 = 857 #

L.L. 150 x 84 = 12,600 #

13,562 #

Beam Wt.:

W 8x24 24x 18 = 432 #

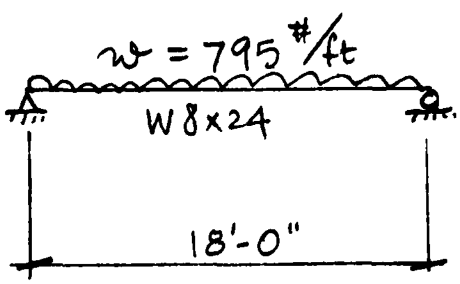
W 6x15.5 15.5x4x5 = 310 #

742 #

Total Weight W = 13,562+742

= 14,304 #

Equivalent Uniform Load w = 795 #/ft




$M_{max} = \frac{1}{8} \times \frac{795}{1000} \times 18^2 \times 12 = 386''^K$

W 8x24 $S_x = 20.8^{in^3}$; $I_x = 82.5^{in^4}$

$(\sigma_t)_{max} = \frac{386}{20.8} = 18.6^{ksi} < 22^{ksi}$ o.K.

$\delta_c = \frac{5 \times .795 \times 18^4 \times 12^3}{384 \times 30{,}000 \times 82.5} = 0.759''$

AISC $\frac{l}{360} = \frac{18 \times 12}{360} = 0.6'' < 0.759''$ N.G.

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Sheet 2-19 of ____

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-2-76 Job No. 27-771-98 Calculation Superstructures (Equipment Deck)

Try W10X29

$S_x = 30.8 \text{ in}^3$

$I_x = 158 \text{ in}^4$

$$(\sigma_t)_{max} = \frac{386}{30.8} = 12.5 \text{ ksi}$$

$$\delta_c = \frac{5 \times .795 \times 18^4 \times 12^3}{384 \times 30,000 \times 158} = 0.396'' < 0.5''$$

O.K.

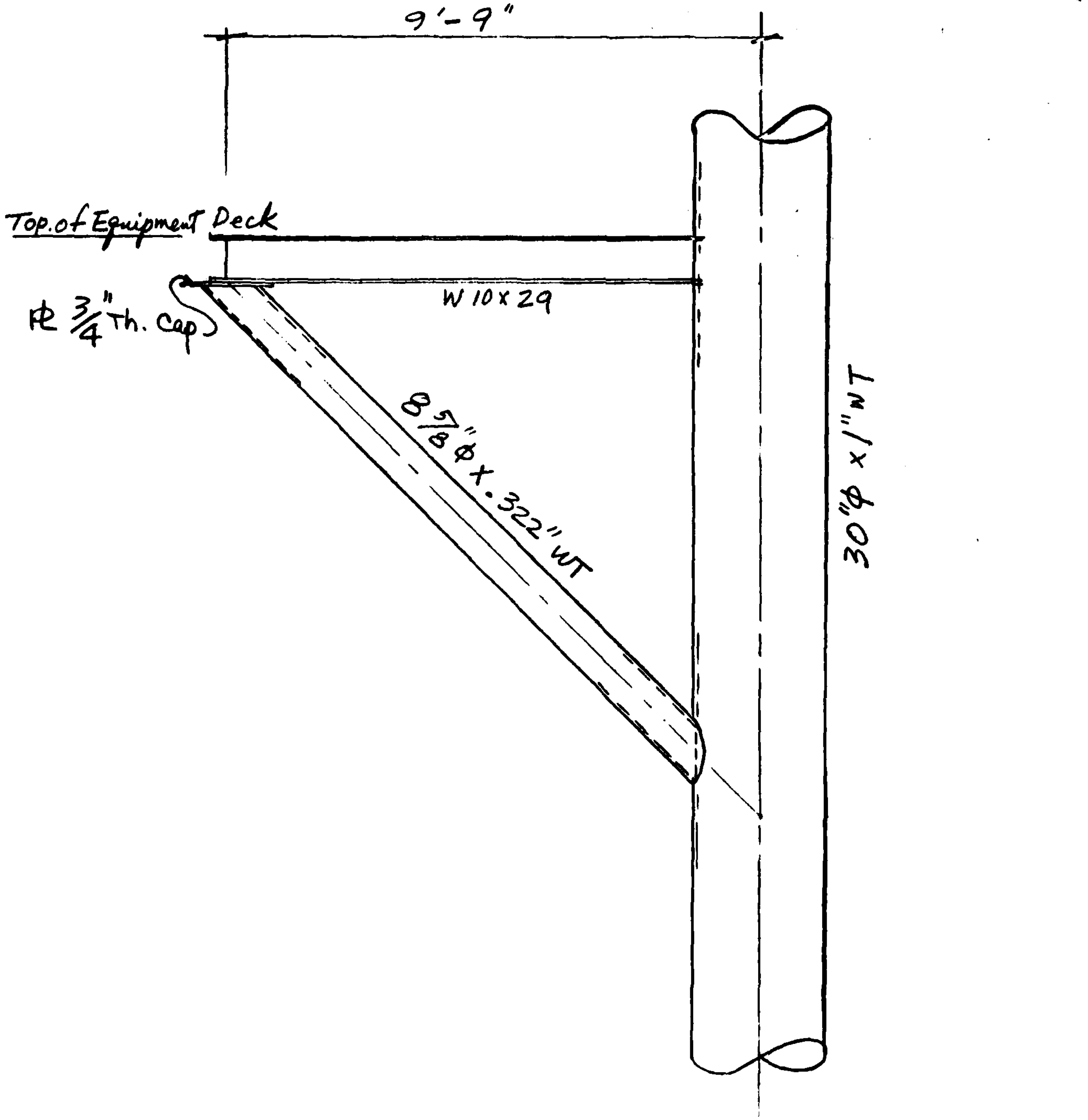
**CREST OFFSHORE, INC.**

Sheet 2.20 of ----

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures

Date 7-2-76 Job No. 27-771-98 Calculation Superstructures (Equipment Deck)

## Section ①-①



**CREST OFFSHORE, INC.**

Sheet 2.21 of ____

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures

Date 7-2-76 Job No. 27-771-98 Calculation Superstructures (Equipment Deck)

Check $8\frac{5}{8}"\phi \times .322"WT$

$A = 8.4$ sq. in

$r = 2.94"$

$L = 13'-9"$

$$n = \frac{KL}{r} = \frac{1 \times 13.75 \times 12}{2.94} = 56$$

$F_a = 17.8$ ksi

$$\text{Axial Load} = \left(\tfrac{1}{2} \times 14{,}304\right) \times \sqrt{2} = 10{,}114\ \#$$

$$f_a = \frac{10.1}{8.4} = 1.2 \text{ ksi} \ll F_a \qquad \text{o.k.}$$

**CREST OFFSHORE, INC.**

Sheet 2-22 of ____

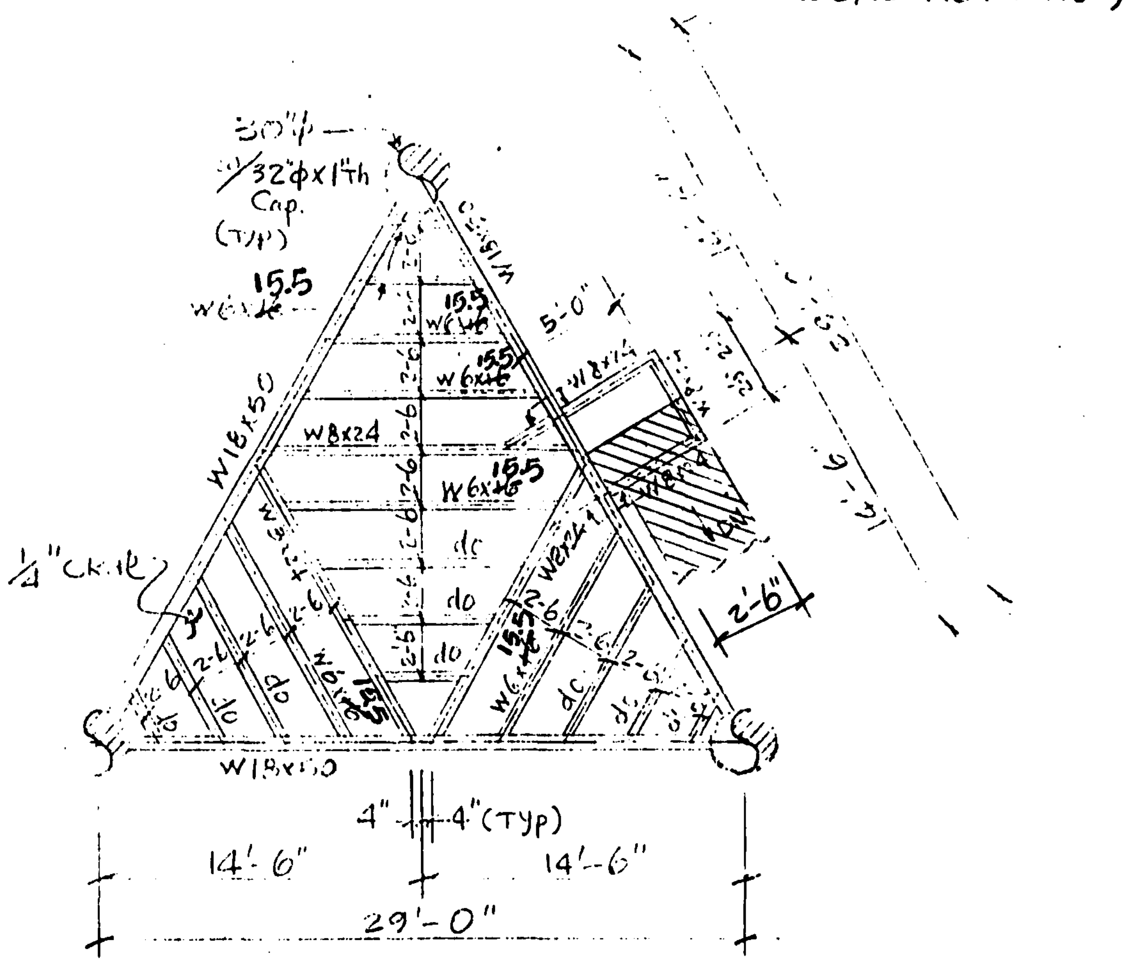
By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-1-76 Job No. 27-771-98 Calculation Superstructures (Stairways)

## 2.5 STAIRWAYS

Design Live Loads on Deck = 150 psf

Design Live Loads on Stairs = 100 psf (AISC)

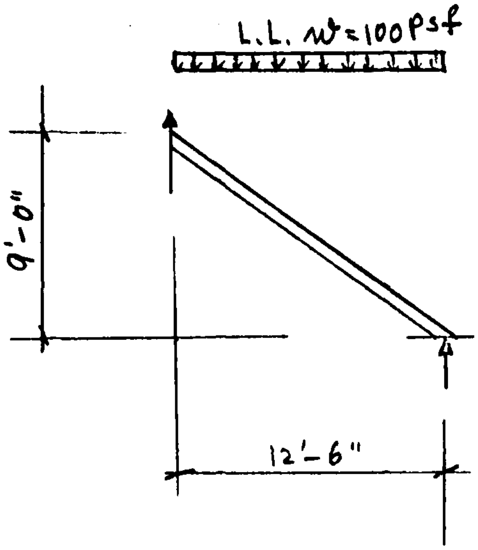
or 1000 LBS Min.
(USAS A64.1-1968)



**CREST OFFSHORE, INC.**

Sheet 2.23 of ____

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-1-76 Job No. 27-271-98 Calculation Superstructures (Stairways)




2-[12 @ 2'-6" Back-to-Back

Say 2 - [12x20.7

$S_x = 21.5 \text{ in}^3$

$$L.L. = 100 \times 2.5 \times \frac{12.5}{\sqrt{9^2 + 12.5^2}}$$

L.L. = 203 Plf

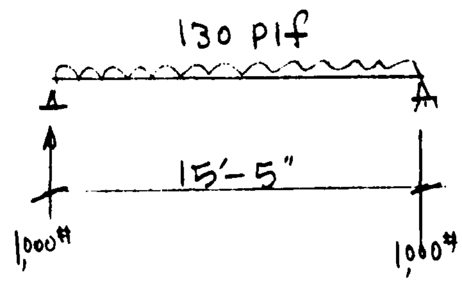
Each Channel L.L. = 102 Plf

D.L. = 21 ([12x20.7)

Misc = 5

Total = 127

Say w = 130 plf




$$M_{max} = \left(\frac{130}{1000}\right) \times \frac{15.4^2 \times 12}{8}$$

$= 46.25''^K$

Moment due to $1^K$ conc. Load.

$$M = \frac{PL}{4} = \frac{1 \times 15.4 \times 12}{4}$$

$= 46.2''^K$

$$(\sigma_b)_{max} = \frac{M}{S} = \frac{46.25}{21.5} = 2.15 \text{ ksi}$$

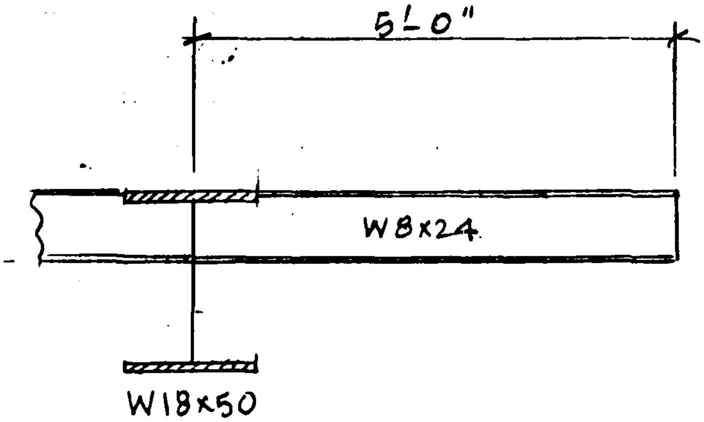
o.k.

**CREST OFFSHORE, INC.**

Sheet 2.24 of ____

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures

Date 7-1-76 Job No. 27-71L-98 Calculation Superstructures (Stairways)




Loads from stairs

$(100 \times 2.5) \times 6.25 + (22+10) \times 7.7$

$= 1563^{\#} + 246^{\#}$

$= 1809^{\#}$

Equivalent uniform load on W8x24

$w_1 = \dfrac{1809}{5} = 362$ plf

Uniform load from 100 psf

$w_2 = 100 \times 2 = 200$ plf

Total uniform loads

$w = w_1 + w_2 = 562$ plf

$$M_{max} = \frac{wl^2}{2} = \frac{.562 \times 5^2 \times 12}{2} = 84.3^{\text{''-K}}$$

W8x24 $S_x = 20.8^{in^3}$

$$(\sigma_b)_{max} = \frac{84.3}{20.8} = 4.05^{ksi}$$

o.k.

**CREST OFFSHORE, INC.**

Sheet 2.25 of ____

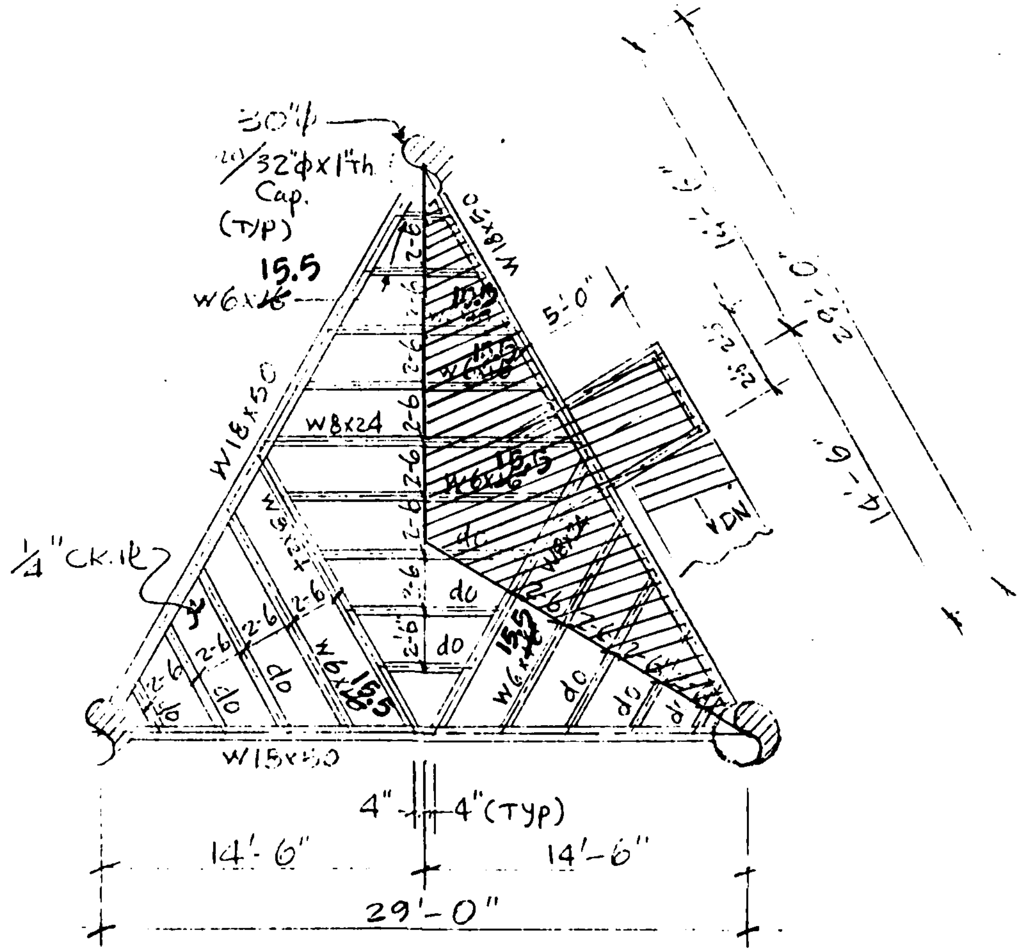
By C. Chern Client U. S. NAVY Subject Miscellaneous Structures

Date 7-1-76 Job No. 27-771-98 Calculation Superstructures (Stairways)

Design Live Loads on Deck = 150 psf

Design Live Loads on Stairs = 100 psf (AISC)

or 1000 LBS Min.
(USAS A64.1-1968)



**CREST OFFSHORE, INC.**

Sheet 2.26 of ____

By C. Chern  Client U.S. NAVY  Subject Miscellaneous Structures
Date 7-1-76  Job No. 27-771-98  Calculation Superstructures (stairways)

W18x50

Additional loads due to stairway reactions

$$W_a = 562 \times 5 + 100 \times 2 \times 5 = 3,810^{\#}$$

Moment due to $W_a$

$$M_a = \frac{W_a L}{4} = \frac{3.81 \times 29 \times 12}{4} = 331.5^{"K}$$

Total moment

$$M = 958.7 + 331.5 = 1,290.2^{"K} < 2,136^{"K}$$

(AISC Allowable)

W18x50  $S_x = 89.1\ in^3$

$$(\sigma_b)_{max} = \frac{1290.2}{89.1} = 14.48^{ksi}$$ o.K.

Total Loads $= 22 + 3.81 = 25.81^K < 49^K$ o.K
(AISC Allowable)

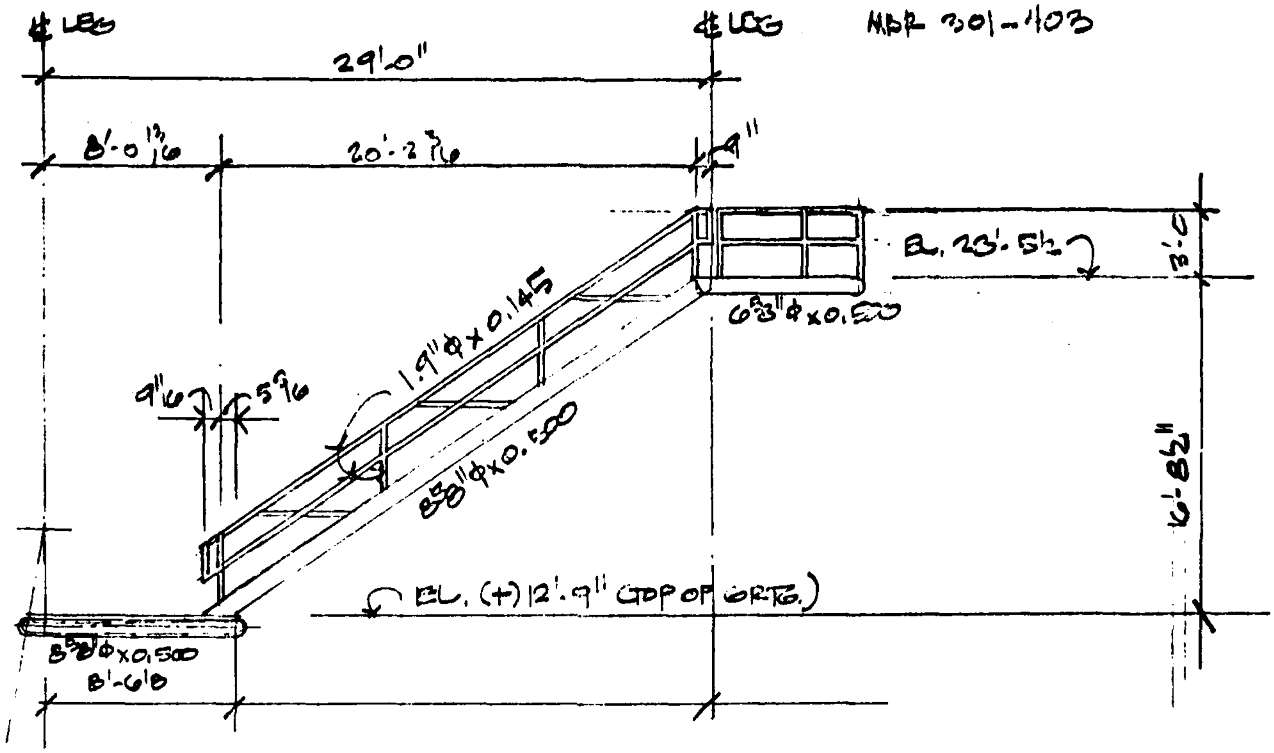
**CREST OFFSHORE, INC.**

Sheet 2.27 of ____

By JWS Client U.S. Navy Subject Miscellaneous Structures
Date 8-12-76 Job No. 27-176-98 Calculation Superstructure

STAIRWAY'S

STAIRWAY #1
MBR 301-403




| ELEVATION | | WAVE FORCE | AVERAGE |
|---|---|---|---|
| 81' + 28.5' = 109.5' ≈ 110' | — | 943 PSF | |
| 100 | — | 605 " | 736.2 PSF |
| 81' + 12.75' = 93.75' | — | 524 " | |
| 90 | — | 476 " | |

PROPERTIES of 8 5/8"φ x 0.500 $A_x$ = 12.763 $I_x$ = 105.743 $S_x$ = 24.520 wt. 43.4 #/'
" " " 1.9"φ x 0.145 = 0.799 = 0.310 = 0.326 2.72 #/'

DEAD LOAD ON STRINGER
HANDRAIL = 2.72 #/' x (7x2+3) = 46.6 ACTING A P LOAD AT 1/3 SPAN
STAIR TREADS = 7.36 #/sf x 1.25' = 9.2 #/'
STRINGER = 43.4
D.L. = 59.2 SAY 60 PLF
L.L. = 150 PSF x 1.25' — = 187.5 PLF
247.5 PLF SAY 250 PLF.

**CREST OFFSHORE, INC.**

Sheet 2.28 of ____

By JWC  Client U.S. NAVY  Subject Miscellaneous Structures
Date 8-11-76  Job No. 21-74-98  Calculation Superstructure

STRINGER

STAIRWAY #1

THERE IS NO AXIAL FORCE ON STRINGER

OR $P = 0$ & $P/A = F_a = 0$

$\therefore$ USE : $\dfrac{\sqrt{f_{by}^2 + f_{bx}^2}}{F_b} \leq 1.0$

$M_y = 0.25(20)^2/8 = 12.5^{1k}$  $f_{by} = 12.5 \times 12 / 24.5 = 6.12$

$M_x = 0.736(1/2)(20)^2/8 = 27.6^{1k}$  $f_{bx} = 27.6 \times 12 / 24.5 = 13.52$

$f_b = \sqrt{f_{by}^2 + f_{bx}^2} = \sqrt{(6.12)^2 + (13.52)^2} = 14.84$

$f_b / F_b = \dfrac{14.84}{0.6 \times 36 \times 1.33} = 0.52 < 1.0 \therefore$ O.K.

$\boxed{8.5'' \phi \times 0.500 \text{ O.K.}}$

HANDRAIL

$\omega = 730^{\#}(2/12) = 123^{\#/'}$

$M = 0.123(5)^2/8 = 0.38^{1k}$

$S_R = \dfrac{0.38^{1k} \times 12''/'}{0.6 \times 36 \times 1.33} = 0.158 \text{ in}^3 < 0.326$ [illegible]

$\boxed{1.9'' \phi \times 0.145 \text{ O.K.}}$

BALASTER

LOAD FROM HANDRAIL $= 123 \times 7' = 861^{\#}$

$M = 0.861 \times 3' + 0.361 \times 1.5' = 3.87^{1k}$

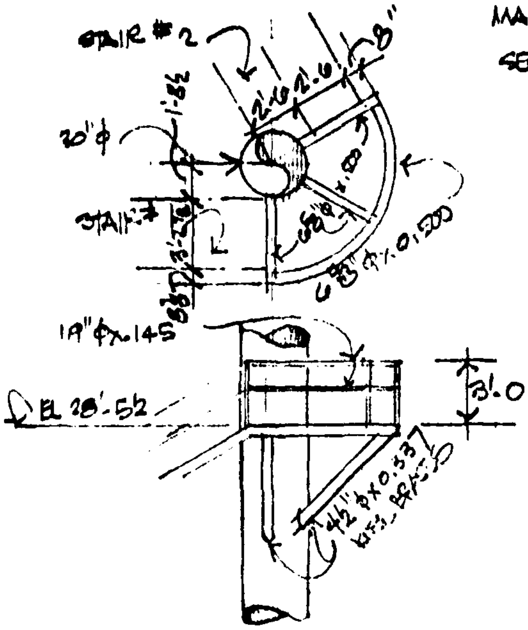
$S_R = \dfrac{3.87 \times 12}{21.6 \times 1.33} = 1.62 \text{ in}^3$

USE [illegible] 2.875"$\phi$ x 0.375 BALASTER'S !
w/ $S_x$ = [illegible]37

**CREST OFFSHORE, INC.**

Sheet 2.29 of ____

By KWS Client U.S. NAVY Subject Miscellaneous Structures
Date 8-10-76 Job No. 27-71-98 Calculation Superstructure




## LANDING #1

LOADING

$81' + 28.5' = 109.5' \approx 110'$

MAX. WAVE FORCE AT ELEV 110' ABOVE MUD LINE = 948 PSF

SECTION PROPERTIES

| SECTION | $A_x$ | $I_x$ | $S_x$ | wt. |
|---|---|---|---|---|
| 6 5/8"φ x 0.500 | 9.621 | 43.43 | 13.72 | 32.71 #/' |
| 4 1/2"φ x 0.337 | 4.407 | 9.613 | 4.272 | 14.98 #/' |
| 1.9"φ x 0.145 | 0.799 | 0.310 | 0.326 | 2.72 #/' |

LANDING BEAM - interior bm

$w = w_{LL} + w_{DL} = 5' \times 150^{\#}/_{SF} + (7.36^{\#/'} \times 5' + 32.71^{\#/'}) = 820^{\#/'}$

$M = 0.82(4.25)^2/8 = 1.85$

$S_R = 1.85 \times 12 / 21.6 = 1.03 in^3 < 13.72$

WAVE LOADING ON O/S bm.

$M = 0.948(7/12)(5)^2/8 + \frac{0.820}{2}(5)^2/8 = 3.01^{K}$

$S_R = 3.01 \times 12 / (21.6 \times 1.33) = 1.26$

$\boxed{\text{6 5/8"φ x 0.500 bm o.k.}}$

KNEE BRACE

$P = [2' \times 5' \times (150 PSF + 7.36) + 7'(32.71 + 2.72 \times 2)] = 1841^{\#}$

$f_a = P/A = \frac{1841^{\#}}{4.407 in^2} = 418$ psi $\quad \frac{kl}{r} = \frac{1.0 \times 6 \times 12}{\sqrt{9.613/4.407}} = 48.7$

$\frac{f_a}{F_a} = \frac{418}{18440} = 0.02 < 0.15 \quad \therefore F_a = 18.44$

$\frac{f_b}{F_b} = \frac{[0.948(\frac{4.5}{12})(6)^2/8][12/4.272]}{21.60} = \frac{4.49}{21.60} = 0.208$

$f_a/F_a + f_b/F_b = 0.02 + 0.208 = 0.228 < 1.0 \therefore$ o.k.

$\boxed{\therefore \text{4 1/2"φ x 0.337 knee brace o.k.}}$

HANDRAIL

$w = 948^{\#}/_{S.F} \times (2/12) = 158$

$M = 0.158(5)^2/8 = 0.494^{1K}$

$S_R = 0.494 \times 12/21.6 = 0.274 < 0.326$

$\boxed{\therefore \text{1.9"φ x 0.145 HANDRAIL o.k.}}$

BALASTER

$M = 0.158 \times 5'(3' + 1.5') = 3.55^{1K}$

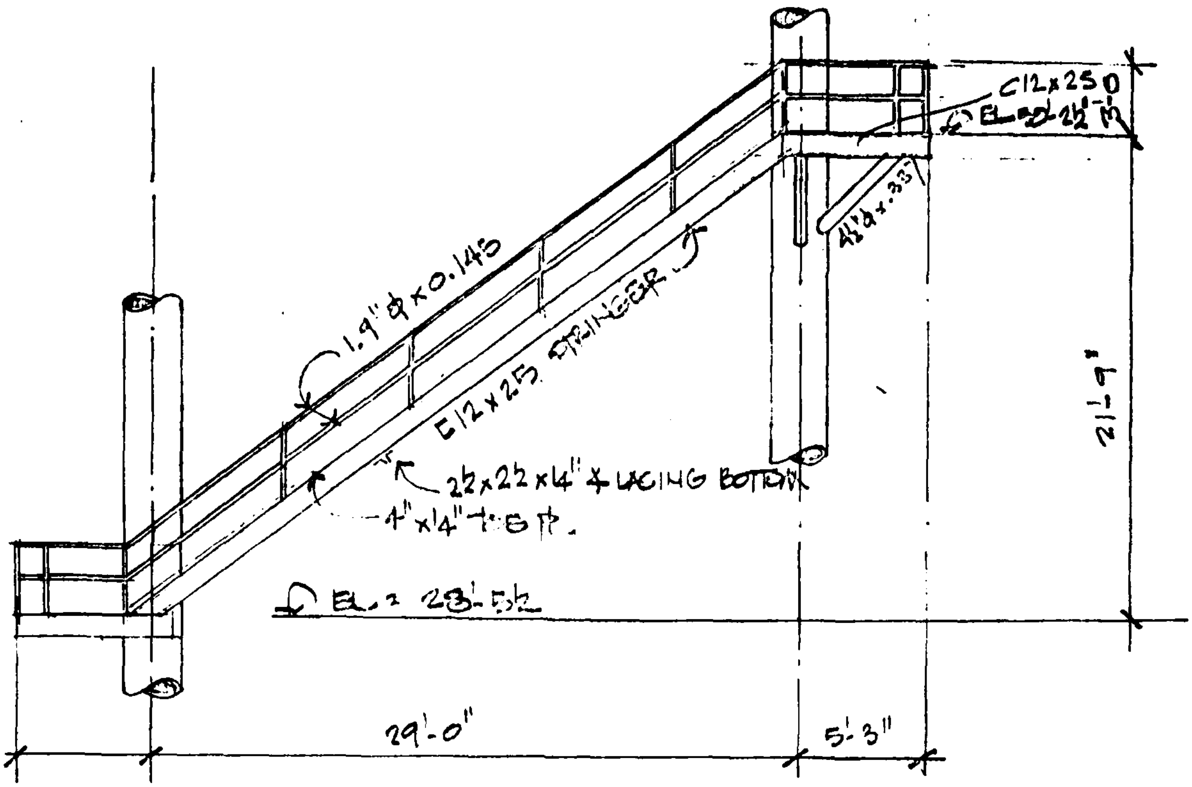
$S_R = 3.55 \times 12 / (21.6 \times 1.33) = 1.48 in^3$

$\boxed{\text{USE 2 7/8"φ x .375 MINIMUM w/} S_x = 1.637}$

**CREST OFFSHORE, INC.**

Sheet 2.30 of ____

By MA ___ Client DS NAVFAC ___ Subject Miscellaneous Structures ___
Date 8.11.76 Job No. 27-771-98 ___ Calculation ___ Superstructure ___




ELEVATION STAIRWAY #2

SECTION PROPERTIES

| SECTION | $A_x$ | wt. | $I_x$ | $S_x$ | $r_x$ | $I_y$ | $S_y$ | $r_y$ |
|---|---|---|---|---|---|---|---|---|
| C 12 x 25 | 7.35 | | 144 | 24.1 | 4.43 | 4.47 | 1.88 | 0.780 |
| 1.9"φ x .145 | 0.799 | 2.72#/' | 0.310 | 0.326 | | | | |
| 2½x2½x¼∠ | 1.19 | 4.1#/' | 0.703 | 0.394 | 0.491 $r_3$ | | | |

LOADINGS

DEAD LOADS: STRINGER = 25 PLF
HANDRAIL = 2 "
TREADS = 10 "/37
LIVE LOAD: 150 PSF x 1.25' = 188 "
TOTAL LOAD = 225 PLF

WAVE LOADING

81' + 50' = 131'  130  784 _ 916
81' + 28.5' = 109.5'  120  1048 _ 998  ASSUME 1000#/S.F.
110  948

**CREST OFFSHORE, INC.**

Sheet 2.31 of ____

By JWD  Client U.S. Navy  Subject *Miscellaneous Structures*
Date 8-11-76  Job No. 27-771-98  Calculation *Superstructure*

STAIRWAY #2

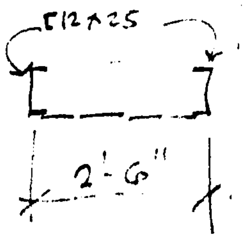
HANDRAIL  $w_{wave} = 1000^{\#}/_{SF} \times (\frac{2}{12}) = 167$ PLF
$M = 0.167\,(6)^2/8 = 0.752^{1k}$
$S_R = 0.752^{1k} \times 12/(21.6 \times 1.33) = 0.314\ in^3 < 0.294$ o.k.
$\boxed{\therefore\ 1.9''\phi \times 0.145\ o.k.}$

BALASTER'S  $P = .167^{k/\prime} \times 6' = 1.0^k$
$M = 1.0^k \times 3' + 1.0^k \times 1.5' = 4.5^{1k}$
$S_R = 4.5 \times 12/(21.6 \times 1.33) = 1.88\ in^3$
$\boxed{\text{USE } 2\tfrac{7}{8}''\phi \times 0.375''}$

STRINGER  $w_{wave} = 1000^{\#}/_{\prime} \times 1' = 1000^{\#}/_{\prime}$
$w_{TL} = 225^{\#}/_{\prime}$

$$f_{bx} = \frac{M_x}{S_x} = \frac{0.225\,(29)^2}{8} \times \frac{12}{24.1} = 11.77 < 21.6 \therefore o.k.$$

Note: for wave force the whole stair ...




$$I = 7.35\,in^2 \left(\frac{30}{2}\right)^2 = 1654\ in^4 \quad S_y = \frac{1654}{15} = 110$$

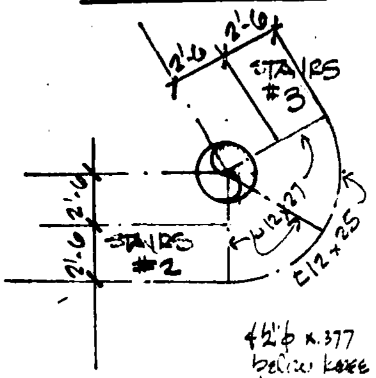
$$f_{by} = \frac{M_y}{S_y} = \frac{1.0\,(29)^2}{8} \times \frac{12}{110} = 11.47\ ksi < 21.6 \times 1.33$$

deck deflection  $\Delta_{all} = L/360 = 29 \times 12/360 = 0.96 \approx 1.0''$

$$\Delta = \frac{5\,(0.225)\,(29)^4 \times 1728}{384 \times 29 \times 144} = 0.86'' < 1.0'' \therefore o.k.$$

$\boxed{\text{C}12 \times 25\ o.k.}$

### LANDING #2




42"φ x.377 below knee brace

SECTION PROPERTIES

| SECTION | $A_x$ | $I_x$ | $S_x$ | wt. | $S_y$ |
|---|---|---|---|---|---|
| C 12x25 | 7.35 | 144 | 24.1 | 25 | |
| W12x27 | 7.95 | 204 | 34.2 | | |
| 42"φx.377 | 4.407 | 9.613 | 4.272 | 14.93#/1 | |

LOADING

WAVE = 784 PSF

INTERIOR LANDING BEAM

$w = w_{LL} + w_{DL} = 5' \times 150^{\#}/_{S.F} + (7.36 \times 5.87) = 814^{\#}/_{1}$

$M = 0.814(4)^2/8 = 1.628^{1K}$

$S_R = 1.628 \times 12 / 21.6 = 0.904\,in^3 < 34.2 \therefore o.k.$

BM SUPPORTING STAIRS STRINGER

$w = \frac{1}{2}\, above = 814/2 = 407^{\#}/_{1}$

$P_{VERT} = 0.225^{K}/_{1} \times 29/2 = 3.26^{K}$

$P_{HOR} = 1.0^{K}/_{1} \times 29/2 = 14.5^{K}$

$M = 0.407(4)^2/2 + 3.26 \times 4 + 3.26 \times 1.5 = 21.2^{1K}$

$f_a = \frac{P}{A} = \frac{14.5^{K}}{7.95\,in^2} = 1.82\,ksi$

$f_b = \frac{M}{S} = \frac{21.2^{1K} \times 12}{21.6} = 11.8\,ksi$

$KL/r: 2 \times 4 \times 12 / \sqrt{204/7.95} = 19 \therefore F_a = 20.66$

$\frac{f_a}{F_a} + \frac{f_b}{F_b} = \frac{1.82}{20.66} + \frac{11.8}{21.6} = 0.63 < 1.0 \therefore o.k.$

OUTSIDE STRINGER

$M_y = 0.784(5)^2/8 = 2.45^{1K}$

$M_x = (2 \times .150 + 2 \times 7.36 + 25)(5)^2/8 = 1.06$

$f_{by} = \frac{2.45^{1K} \times 12}{1.88} = 15.64$

$f_{bx} = \frac{1.06 \times 12}{24.1} = 0.53$

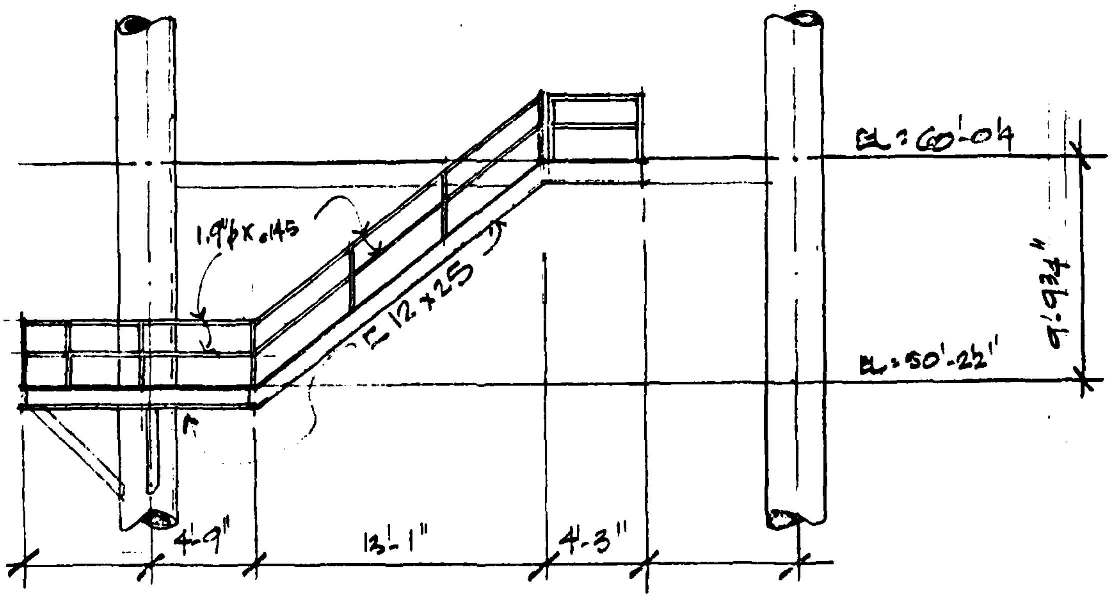
$\frac{f_{by}}{F_{by}} + \frac{f_{bx}}{F_{bx}} = \frac{15.64}{21.6 \times 1.33} + \frac{0.53}{21.6} = 0.57 < 1.0 \therefore o.k.$

**CREST OFFSHORE, INC.**

Sheet 2.33 of ____

By [illegible] Client [illegible] Subject *Miscellaneous Structures*

Date 8-11-76 Job No. 27-771-98 Calculation *Superstructure*




STAIRWAY #3

SECTION PROPERTIES

| SECTION | $A_x$ | $I_x$ | $S_x$ | $S_y$ | wt. |
|---|---|---|---|---|---|
| C 12x25 | 7.35 | 144 | 24.1 | 1.88 | |
| 1.9"φ x .145 | 0.799 | 0.310 | 0.326 | | 2.72 #/' |

STAIR STRINGER

$w_{VERT} = 225$ PCF (see stair #2)

$M = 0.225(18)^2/8 = 9.11^{1K}$

$S_R = 9.11 \times 12 / 21.6 = 5.06 < 24.1$

CK DEFLECTION $\Delta_{all} = 18 \times 12/240 = 0.9$

$$\Delta = \frac{5(.225)(18)^4\,1728}{384 \times 29 \times 144} = 0.13''$$

∴ o.k.

WAVE FORCE = 537 PSF

TWO STAIR STRINGERS & ∠'s & TREADS FORM TRUSS w/ $S_x = 110\ in^3$ (see #2)

$M = 0.537(18)^2/8 = 21.75^{1K}$

$f_b = 21.75 \times 12/110 = 2.37$ ksi $< 21.6$ ∴ o.k.

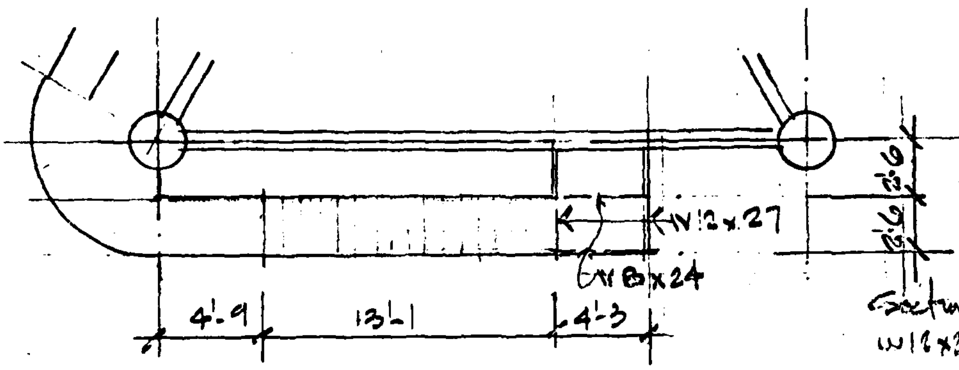
HANDRAILS & BALUSTERS

NEGLECT BY INSPECTION

# CREST OFFSHORE, INC.

Sheet 234 of ____

By JMS Client OSI[illegible] Subject Miscellaneous Structures
Date 8-12-78 Job No. 21-17E-98 Calculation Superstructure




| Section | $I_x$ | $S_x$ |
|---|---|---|
| W12x27 | 204 | 34.2 |
| W8x24 | 82.5 | 20.8 |

LANDING # 3 @ ELEV. 60'-0"

VERT LOAD FR. STAIRS = $P_V = 0.225 \times 18/2 = 2.025^k$
HOR. " " " (WAVE) = $P_H = 0.537 \times 18/2 = 4.833^k$
$w_{LOAD} = 2' \times 150 + 50 = 350^{\#/'}$
$M = 0.35(5)^2/2 + 2.025(2.5+5) = 19.56^{1k}$
$KL/r_y = 2 \times 5 \times 12 / 1.52 = 79 \therefore F_a = 15.47$
$f_a = \frac{P}{A} = \frac{4.833^k \times 2}{34.2} = 0.28$ ksi.

$f_b = \frac{M}{S} = \frac{19.56^{1k} \times 12}{34.2} = 6.86$ ksi

$\frac{f_a}{F_a} + \frac{f_b}{F_b} = \frac{0.28}{15.47} + \frac{6.86}{21.6} = 0.34 < 1.0 \therefore$ o.k.

NOTE: NO WAVE ON LANDING ITSELF

INT. PURLIN

$w = 350^{\#/'}$
$M = 0.35(4)^2/8 = 0.7^{1k}$
$f_b = \frac{0.7 \times 12}{20.8} = 0.40$ ksi $< 21.6$ ksi $\therefore$ o.k.

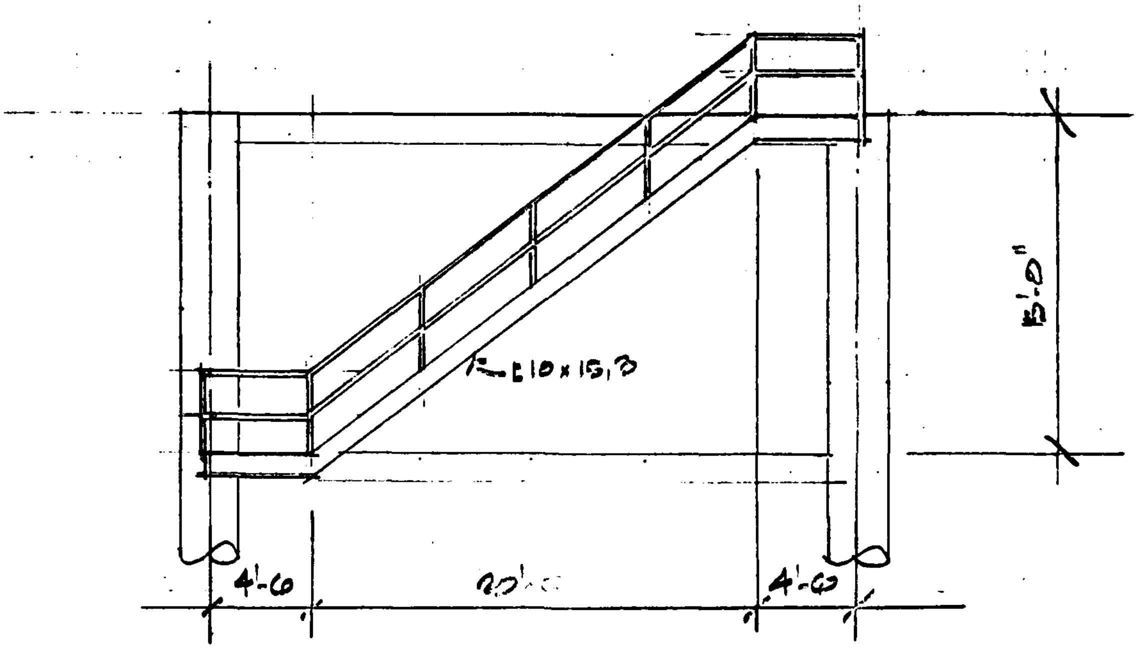
HANDRAILS:

NEGLECT BY INSPECTION

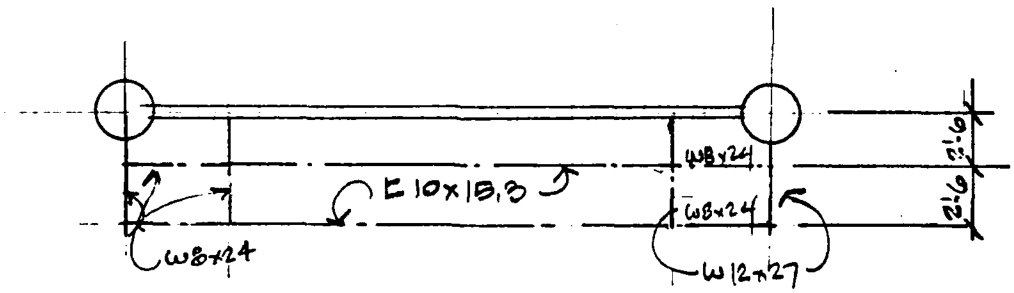
**CREST OFFSHORE, INC.**

Sheet 2.35 of

By JMA Client U.S. NAVY Subject *Miscellaneous Structures*
Date 8-12-76 Job No. 27-771-98 Calculation *Superstructure*




ELEV. STAIR #4




STAIR #4 PLAN

SECTION PROPERTIES

| SECTION | A | $I_x$ | $S_x$ | $r_x$ | $S_y$ | $r_y$ |
|---|---|---|---|---|---|---|
| C10x15.3 | 4.49 | 67.4 | 13.5 | 3.87 | 1.16 | 0.713 |
| W8x24 | 7.06 | 82.4 | 20.8 | 3.42 | 5.61 | 1.61 |
| W12x27 | 7.95 | 204 | 34.2 | 5.07 | 5.63 | 1.52 |

LOADING

NOTE NO WAVE LOAD WILL OCCUR ON THIS STAIR
DEAD LOAD = ACTUAL
LIVE LOAD = 150 PSF

**CRST OFFSHORE, INC.**

Sheet 236 of ____

By MWS Client [illegible] Subject Miscellaneous Structures
Date 8-13-76 Job No. 27-771-98 Calculation Superstructure

STAIR # 4

HANDRAILS - NEGLECT BY INSPECTION

STRINGERS

$w_T = w_{DL} + w_{LL} = 1.25' \times 10 + 15.3 + 1.25 \times 150 = 215^{\#/'}$

$M = 0.215(20)^2/8 = 10.8^{'k}$

$f_b = 10.8 \times 12 / 13.5 = 9.60 < 21.6 \therefore o.k.$

WIND = 25PSF

$M = 0.025(20)^2/8 = 1.25$

$f_b = 1.25 \times 12 / 1.16 = 12.93$

(STAIRS FORMS TRUSS & WIND WILL BE INSIGNIFICANT)

$S_y$ for truss $\approx 100 \text{ in}^3$

$f_b = 1.25 \times 12 / 100 = 0.15 < 21.6$

check deflection $\Delta all = L/360 = 20 \times 12 / 360 = 0.67$

$$\Delta actual = \frac{5(0.225)(20)^4 1728}{384 \times 29 \times 07.4} = 0.414 < 0.67$$

LOWER LANDING

PLOAD FROM STRINGERS $= 10' \times 215^{\#} = 2150^{\#}$

$M = (5.0+2.5)(2.15^k) + (2' \times 170^{\#/'})(5)^2/2 = 20.375^{'k}$

$$f_b = \frac{20.375^{'k} \times 12}{20.8 \text{ in}^3} = 11.75 \text{ ksi} < 21.6 \therefore o.k.$$

check deflection $\Delta all = L/360 = 5 \times 12/360 = 0.17''$

$$\Delta actual = \frac{(2 \times .17)(5)^4 \times 1.728}{8 \times 29 \times 82.4} + \frac{2.15(5)^3 \times 1.728}{3 \times 29 \times 82.4} + \frac{2.15(2.5)^2(3 \times 5 - 2.5) 1.728}{6 \times 29 \times 82.4}$$

$$= 0.019 + 0.065 + .020 = 0.104 < 0.17$$

$\therefore o.k.$

UPPER LANDING

BY INSPECTION IF W8x24 WORKS FOR LOWER LANDING W12x27 WILL BE O.K FOR UPPER LANDING

# CREST OFFSHORE, INC.



By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-14-76 Job No. 27-771-9B Calculation Superstructures

## 2.6 DEAD WEIGHT OF SUPERSTRUCTURE

| MEMBER SIZE | MEMBER LENGTH | NO. REQUIRED | TOTAL LENGTH | UNIT WEIGHT | TOTAL WEIGHT |
|---|---|---|---|---|---|
| IN. x IN. | FT | | FT | LBS/FT | LBS |
| 42"Φ x 1.0" WT | 5.0 | 3 | 15.0 | 473.39 | 7,100.9 |
| 30"Φ x 1.0" WT | 50.5 | 3 | 151.5 | 309.73 | 46,924.1 |
| 42"Φ x 30"Φ x 1" WT Cone | 3.0 | 3 | 9.0 | 391.56 | 3,524.0 |
| 14"Φ x .5" WT | 32.65 | 3 | 97.95 | 72.09 | 7,061.2 |
| 12¾"Φ x .5" WT | 29.0 | 3 | 87.0 | 65.42 | 5,691.5 |
| | | | | | 70,301.7 |
| EQUIPMENT DECK | | | | | |
| W 18x50 | 29.0 | 2 | 58.0 | 50.0 | 2,900.0 |
| W 21x73 | 29.0 | 1 | 29.0 | 73.0 | 2,117.0 |
| W 10x29 | 38.0 | 1 | 38.0 | 29.0 | 1,102.0 |
| W 8x24 | 14.5 | 3 | 43.5 | 24.0 | 1,044.0 |
| W 8x24 | 5.0 | 2 | 10.0 | 24.0 | 240.0 |
| W 8x24 | 4.0 | 1 | 4.0 | 24 | 96.0 |
| W 6x16* | 8.0 | 7 | 56.0 | 16 | 896.0 |

**CREST OFFSHORE, INC.**

Sheet 2.38 of ____

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-14-76 Job No. 27-771-98 Calculation Superstructures

| MEMBER SIZE | MEMBER LENGTH | NO. REQUIRED | TOTAL LENGTH | UNIT WEIGHT | TOTAL WEIGHT |
|---|---|---|---|---|---|
| IN. x IN. | FT | | FT | LBS/FT | LBS |
| W 6x16* | 4.0 | 2 | 8.0 | 16.0 | 128.0 |
| W 6x16* (2.9'+5.8'+8.7'+11.6') | 29.0 | 4 | 116.0 | 16.0 | 1,856.0 |
| 1/4" PL | 362.5□' | 1 | 362.5 | 10.2 | 3,697.5 |
| 1/4" PL | 188.0□' | 1 | 188.0 | 10.2 | 1,917.6 |
| 8 5/8" Φ x .322" WT | 13.8 | 2 | 27.6 | 28.55 | 787.2 |
| | | | | | 16,781.3 |
| UPPER DECK | | | | | |
| W18x50 | 29.0 | 3 | 87.0 | 50.0 | 4,350.0 |
| W 8x24 | 14.5 | 3 | 43.5 | 24.0 | 1,044.0 |
| W6x16* | 7.25 | 4 | 29.0 | 16.0 | 464.0 |
| 4"x3/8" FB | 37.5 | 4 | 150.0 | 5.1 | 765.0 |
| 1/4" PL | 362.5□' | 1 | 362.5 | 10.2 | 3,697.5 |
| 32" Φ x 1" Th. Cap. | 5.6□' | 3 | 16.8 | 40.8 | 685.4 |
| | | | | | 11,005.9 |
| | | | | | 98,088.9 |

**CREST OFFSHORE, INC.**

Sheet 2.39 of ____

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-14-76 Job No. 27-771-98 Calculation Superstructures

| MEMBER SIZE | MEMBER LENGTH | NO. REQUIRED | TOTAL LENGTH | UNIT WEIGHT | TOTAL WEIGHT |
|---|---|---|---|---|---|
| IN. x IN. | FT | | FT | LBS/FT | LBS |
| STAIRS #1 | | | | | |
| [ 12x25 | 25.22 | 2 | 50.44 | 25.0 | 1,261.0 |
| Treads | | 25 | | 25.0 ea. | 625.0 |
| 1/4" x 4" PL | 25.22 | 2 | 50.44 | 3.40 | 171.5 |
| 1.9"Φ x .145" WT | 25.22 | 4 | 100.88 | 2.72 | 274.4 |
| " | 11.0 | 6 | 66.0 | 2.72 | 179.5 |
| " | 8.25 | 8 | 66.0 | 2.72 | 179.5 |
| " | 3.0 | 4 | 12.0 | 2.72 | 32.6 |
| ∠ $2\frac{1}{2}$ x $2\frac{1}{2}$ x 1/4 | 30.0 | 1 | 30.0 | 4.10 | 123.0 |
| [ 10x20 | 10.5 | 1 | 10.5 | 20.0 | 210.0 |
| " | 4.25 | 3 | 12.75 | " | 255.0 |
| " | 6.0 | 3 | 18.0 | " | 360.0 |
| Grating | 26.2 SQ.FT | 1 | | 9.04 | 236.8 |
| 1.9"Φ x .145" WT | 10.5 | 2 | 21.0 | 2.72 | 57.2 |
| " | 3.5 | 4 | 14.0 | " | 38.1 |
| EL.(+) 12'-9 1/4" TO EL.(+) 29'-1" | | | | | 4,003.6 |

**CREST OFFSHORE, INC.**

Sheet 2.40 of ____

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-16-76 Job No. 27-771-98 Calculation Superstructures

| MEMBER SIZE | MEMBER LENGTH | NO. REQUIRED | TOTAL LENGTH | UNIT WEIGHT | TOTAL WEIGHT |
|---|---|---|---|---|---|
| | FT | | FT | LBS/FT | LBS |
| STAIRS #2 | | | | | |
| [ 12x25 | 36.25 | 2 | 72.5 | 25.0 | 1,812.5 |
| Treads | | 34 | | 25.0 ea | 850.0 |
| 1/4"x4" PL | 36.25 | 2 | 72.5 | 3.4 | 246.5 |
| 1.9"Φx.145"WT | 36.25 | 4 | 145.0 | 2.72 | 394.4 |
| " | 3.5 | 12 | 42.0 | " | 114.2 |
| ∠ 2½x2½x¼ | 40.0 | 1 | 40.0 | 4.10 | 164.0 |
| [ 10x20 | 10.5 | 1 | 10.5 | 20.0 | 210.0 |
| " | 4.25 | 3 | 12.75 | 20.0 | 255.0 |
| " | 6.0 | 3 | 18.0 | 20 | 360.0 |
| Grating | 26.2 SQ.FT | 1 | | 9.04 | 236.8 |
| 1.9"Φx.145"WT | 10.5 | 2 | 21.0 | 2.72 | 57.2 |
| " | 3.5 | 4 | 14.0 | " | 38.1 |
| | | | | | 4,738.7 |
| EL.(+)29'-1" to EL.(+) 50'-10" | | | | | |

**CREST OFFSHORE, INC.**

Sheet 2.41 of ____

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures

Date 7-16-76 Job No. 27-771-98 Calculation Superstructures

| MEMBER SIZE | MEMBER LENGTH | NO. REQUIRED | TOTAL LENGTH | UNIT WEIGHT | TOTAL WEIGHT |
|---|---|---|---|---|---|
| | FT | | FT | LBS/FT | LBS |
| STAIRS #3 | | | | | |
| [12x25 | 5.0 | 2 | 10.0 | 25.0 | 250.0 |
| [12x25 | 15.3 | 2 | 30.6 | " | 765.0 |
| Treads | | 15 | | 25.0 | 375.0 |
| 1/4"x4" PL | 20.3 | 2 | 40.6 | 3.4 | 138.0 |
| Grating | 12.5 SQ.FT | 1 | | 9.04 | 113.0 |
| 1/4"x4" PL | 14.2 | 1 | 14.2 | 3.4 | 48.3 |
| Grating | 20.0 | 1 | | 9.04 | 180.8 |
| 1.9"Φx.145"WT | 20.3 | 4 | 81.2 | 2.72 | 220.9 |
| " | 3.5 | 10 | 35.0 | " | 95.2 |
| " | 29.0 | 1 | 29.0 | " | 78.9 |
| EL.(+)50'-10" to EL.(+) 60'-0" | | | | | 2,265.1 |
| STAIRS #4 SAME AS STAIRS #3 | | | | | 2,265.1 |
| TOTAL STAIRS | | | | | 13,272.5 LBS |

# CREST OFFSHORE, INC.

Sheet 2.42 of ____

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-16-76 Job No. 27-771-98 Calculation Superstructures

| MEMBER SIZE | MEMBER LENGTH | NO. REQUIRED | TOTAL LENGTH | UNIT WEIGHT | TOTAL WEIGHT |
|---|---|---|---|---|---|
| | FT | | FT | LBS/FT | LBS |
| HAND RAILS ON DECKS | | | | | |
| UPPER DECK | | | | | |
| 1.9"ϕ x .145" WT | 29.0 | 6 | 174.0 | 2.72 | 473.3 |
| " | 3.5 | 27 | 94.5 | " | 257.0 |
| EQUIPMENT DECK | | | | | |
| 1.9"ϕ x .145" WT | 29.0 | 4 | 116.0 | 2.72 | 315.5 |
| " | 38.0 | 2 | 96.0 | " | 216.1 |
| " | 3.5 | 29 | 101.5 | " | 276.1 |
| | | | | | 1,538.0 |
| Kick Plates | | | | | |
| ¼" x 4" PL | 29.0 | 3 | 87.0 | 3.4 | 295.8 |
| ¼" x 4" PL | 29.0 | 2 | 58.0 | 3.4 | 197.2 |
| " | 38.0 | 1 | 38.0 | " | 129.2 |
| | | | | | 622.2 |
| | | | | | 2,160.2 |

**CREST OFFSHORE, INC.**

Sheet 2.43 of ____

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-16-76 Job No. 27-771-98 Calculation Superstructures

## SUMMARY

| | |
|---|---|
| SUPERSTURE LEG & TUBULAR BRACES | 70, 302 LBS |
| EQUIPMENT DECK | 16, 781 LBS |
| UPPER DECK | 11, 006 LBS |
| STAIRS | 13, 273 LBS |
| HAND RAILS (DECKS) | 2, 160 LBS |
| | 113, 522 LBS |

113.5 kips

( $56\frac{3}{4}$ TONS )

* W6x16 changed to W6x15.5

**CREST OFFSHORE, INC.**

Sheet 2.44 of ____

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-15-76 Job No. 27-771-98 Calculation Superstructures

## 2.7 PAINT AREA

| MEMBER SIZE | MEMBER LENGTH (C. to C.) | SURFACE AREA | NO. REQUIRED | TOTAL AREA | NOTES |
|---|---|---|---|---|---|
| | FT | SQ. FT | | SQ. FT | |
| 42"Φ x 1" WT | 5.0 | 55.0 | 3 | 165.0 | JKT LEG |
| 30"Φ x 1" WT | 50.5 | 396.6 | 3 | 1,189.8 | " |
| 42"Φ x 30"Φ x 1" WT (Cone) | 3.0 | 28.3 | 3 | 84.8 | " |
| 14"Φ x .5" WT | 32.65 | 119.7 | 3 | 359.0 | Verti. Braces |
| 12¾"Φ x .5" WT | 29.0 | 96.8 | 3 | 290.4 | Horiz. Braces |
| | | | | 2,089.0 | |
| W 18 x 50 | 29.0 | 246.5 | 2 | 493.0 | Equipment Deck |
| W 21 x 73 | 29.0 | 287.6 | 1 | 287.6 | " |
| W 10 x 29 | 38.0 | 101.3 | 1 | 101.3 | " |
| W 8 x 24 | 14.5 | 35.0 | 3 | 105.0 | " |
| W 8 x 24 | 5.0 | 12.1 | 2 | 24.2 | " |
| W 8 x 24 | 4.0 | 9.7 | 1 | 9.7 | " |
| W 6 x 16* | 8.0 | 13.7 | 7 | 95.7 | " |

**CREST OFFSHORE, INC.**

Sheet 2.45 of ____

By C. Chern Client U. S. NAVY Subject Miscellaneous Structures

Date 7-15-76 Job No. 27-771-98 Calculation Superstructures

| MEMBER SIZE | MEMBER LENGTH (C. to C.) | SURFACE AREA | NO. REQUIRED | TOTAL AREA | NOTES |
|---|---|---|---|---|---|
| | FT | SQ. FT | | SQ. FT | |
| W 6x16* | 4.0 | 6.8 | 2 | 13.6 | Equipment Deck |
| W 6x16* (2.9+5.8+8.7+11.6) | 29.0 | 49.5 | 4 | 198.0 | " |
| 1/4" PL | | 362.5 | 2 | 725.0 | " |
| 1/4" PL | | 188.0 | 2 | 376.0 | " |
| 8 5/8"φ x .322" WT | 13.8 | 31.2 | 2 | 62.4 | " |
| | | | | 2,491.5 | |
| W18x50 | 29.0 | 123.3 | 3 | 369.9 | Upper Deck |
| W 8x24 | 14.5 | 35.0 | 3 | 105.0 | " |
| W 6x16 | 7.25 | 12.4 | 4 | 49.6 | " |
| 4"x 3/8" FB | 37.5 | 25.0 | 4 | 100.0 | " |
| 1/4" PL | | 362.5 | 2 | 725.0 | " |
| | | | | 1,349.5 | |

**CREST OFFSHORE, INC.**

Sheet 246 of ____

By C. Chon Client U.S. NAVY Subject Miscellaneous Structures
Date 7-16-76 Job No. [illegible] Calculation Superstructures

| MEMBER SIZE | MEMBER LENGTH (C. TO C.) | SURFACE AREA | NO. REQUIRED | TOTAL AREA | NOTES |
|---|---|---|---|---|---|
| | FT | SQ. FT | | SQ. FT | |
| [12 x 25 | 25.22 | 151.3 | 2 | 302.6 | STAIRS #1 |
| Treads | | 4.1 | 25 | 102.5 | |
| 1/4" x 4" ℄ | 25.22 | 16.8 | 2 | 33.6 | |
| 1.9"Φ x .145"WT | 25.22 | 12.5 | 4 | 50.0 | |
| " | 11.0 | 5.5 | 6 | 33.0 | |
| " | 8.25 | 4.1 | 8 | 32.8 | |
| " | 3.0 | 1.5 | 4 | 6.0 | |
| ∠2½x2½x¼ | 30.0 | 25.0 | 1 | 25.0 | |
| [10 x 20 | 10.5 | 27.1 | 1 | 27.1 | |
| " | 4.25 | 11.0 | 3 | 33.0 | |
| " | 6.0 | 15.5 | 3 | 46.5 | |
| Grating | 26.2 SQ FT | 52.4 | 1 | 52.4 | |
| 1.9Φ x .145WT | 10.5 | 5.2 | 2 | 10.4 | |
| " | 3.5 | 1.7 | 4 | 6.8 | |
| | | | | 761.7 | |

# CREST OFFSHORE, INC.

Sheet 2.47 of ____

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-16-76 Job No. 27-771-98 Calculation Superstructures

| MEMBER SIZE | MEMBER LENGTH (C. TO C.) | SURFACE AREA | NO. REQUIRED | TOTAL AREA | NOTES |
|---|---|---|---|---|---|
| | FT | SQ. FT | | SQ. FT | |
| [12x25 | 36.25 | 108.8 | 2 | 217.6 | STAIRS #2 |
| Treads | | 4.1 | 34 | 139.4 | |
| 1/4"x4" PL | 36.25 | 24.2 | 2 | 48.4 | |
| 1.9"Φx.145"WT | 36.25 | 18.0 | 4 | 72.0 | |
| " | 3.5 | 1.74 | 12 | 20.9 | |
| ∠2½x2½x¼ | 40.0 | 16.7 | 1 | 16.7 | |
| [10x20 | 10.5 | 27.1 | 1 | 27.1 | |
| " | 4.25 | 11.0 | 3 | 33.0 | |
| " | 6.0 | 15.5 | 3 | 46.5 | |
| Grating | 26.2 SQ. FT | 52.4 | 1 | 52.4 | |
| 1.9"Φx.145"WT | 10.5 | 5.2 | 2 | 10.4 | |
| " | 3.5 | 1.7 | 4 | 6.8 | |
| | | | | 691.2 | |

**CREST OFFSHORE, INC.**

Sheet 2.48 of ____

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures

Date 7-16-76 Job No. 27-77L-98 Calculation Superstructures

| MEMBER SIZE | MEMBER LENGTH (C. TO C.) | SURFACE AREA | NO. REQUIRED | TOTAL AREA | NOTES |
|---|---|---|---|---|---|
| | FT | SQ.FT | | SQ.FT | |
| [ 12x25 | 5.0 | 15.0 | 2 | 30.0 | STAIRS #3 |
| [ 12x25 | 15.3 | 45.9 | 2 | 91.8 | |
| Treads | | 4.1 | 15 | 61.5 | |
| 1/4"x4" PL | 20.3 | 13.5 | 2 | 27.0 | |
| Grating | 12.5 SQ.FT | 25.0 | 1 | 25.0 | |
| 1/4"x4" PL | 14.2 | 9.5 | 1 | 9.5 | |
| Grating | 20.0 SQ.FT | 40.0 | 1 | 40.0 | |
| 1.9"Φx.145"WT | 20.3 | 10.1 | 4 | 40.4 | |
| " | 3.5 | 1.74 | 10 | 17.4 | |
| " | 29.0 | 14.4 | 1 | 14.4 | |
| | | | | 357.0 | |
| | | | | 357.0 | STAIRS #4 |
| | | | | 2,166.9 | TOTAL STAIRS |

**CREST OFFSHORE, INC.**

Sheet 2.49 of ____

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures

Date 7-16-76 Job No. 27-771-98 Calculation Superstructures

| MEMBER SIZE | MEMBER LENGTH (C. TO C.) | SURFACE AREA | NO. REQUIRED | TOTAL AREA | NOTES |
|---|---|---|---|---|---|
| | FT | SQ. FT | | SQ. FT | |
| | | | | | Hand Rails on Decks |
| 1.9"Φ x .145" WT | 29.0 | 14.4 | 6 | 86.4 | Upper Deck |
| " | 3.5 | 1.74 | 27 | 47.0 | |
| 1/4" x 4" ℄ | 29.0 | 19.3 | 3 | 58.0 | |
| 1.9"Φ x .145" WT | 29.0 | 14.4 | 4 | 57.6 | Equipment Deck |
| " | 38.0 | 18.9 | 2 | 37.8 | |
| " | 3.5 | 1.74 | 29 | 50.5 | |
| 1/4" x 4" ℄ | 29.0 | 19.3 | 2 | 38.6 | |
| " | 38.0 | 25.3 | 1 | 25.3 | |
| | | | | 401.2 | |

**CREST OFFSHORE, INC.**

Sheet 2-59 of ____

By C. Cherry Client U.S. Navy Subject Miscellaneous Structures
Date 7-16-76 Job No. 2773-98 Calculation Superstructure

## SUMMARY

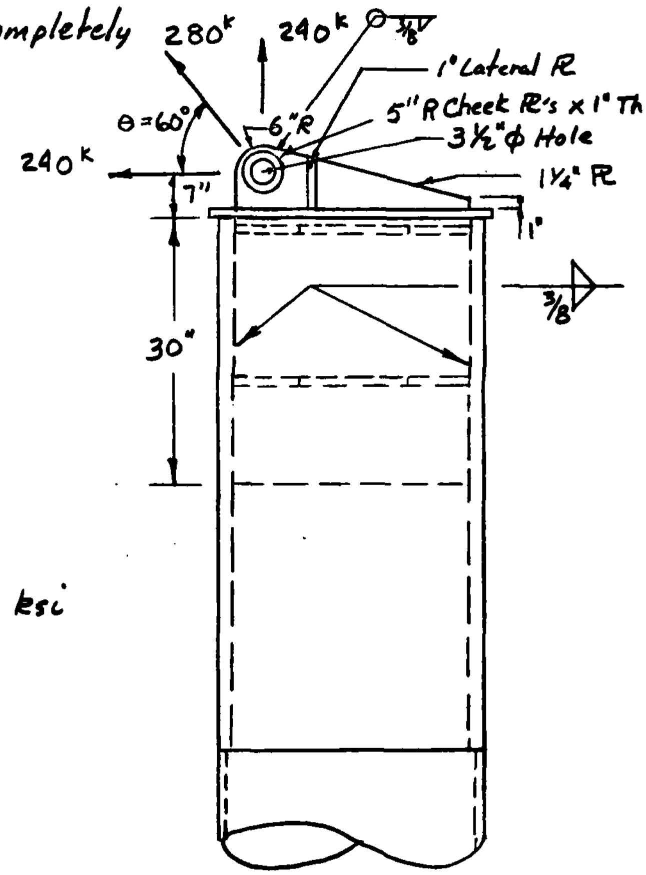
| | |
|---|---|
| SUPERSTRUCTURE LEG & TUBULAR BRACES | 2,089 SQ.FT |
| EQUIPMENT DECK | 2,492 SQ.FT |
| UPPER DECK | 1,350 SQ.FT |
| STAIRS | 2,167 SQ.FT |
| HANDRAILS & KICK PLATES (DECKS) | 401 SQ.FT |
| | 8,499 SQ.FT |
| | (8,500 SQ.FT) |

*W 6x16 was changed to W 6x15.5

## Lifting Eyes - Superstructure

Weight of Superstructure = $120^k$

Assume entire weight is at one lift eye.
Assume impact factor of 2.0.
Assume total applied load of $240^k$ can be acting completely vertical or completely horizontal.
Assume sling $\theta = 60°$.




### Check Shear in Pin:

Use 3.25" Diameter Pin -

$$\frac{P}{A} = \frac{280^k}{2\,(\pi\, 1.625^2)} = 16.9 \text{ ksi}$$

$$F_s = 0.4\,(36 \text{ ksi}) \times 1.33 = 19.2 \text{ ksi}$$

$$16.9 < 19.2$$

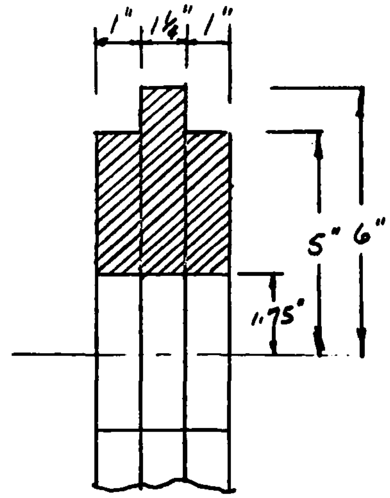
### Check Bearing on Plate

$$\frac{P}{Dt} = \frac{280^k}{(3.25)(3.25)} = 26.5 \text{ ksi}$$

$$F_{br} = 0.9\,(36 \text{ ksi}) = 32.4 \text{ ksi}$$

$$26.5 < 32.4$$

## Check Pin Shearing Through Plates




$$A = 4\left[(5-1.75) \times 1.0\right] + 2\left[(6-1.75) \times 1.25\right]$$

$$A = 13.0 + 10.6 = 23.6 \text{ in}^2$$

$$f_s = \frac{280^k}{23.6 \text{ in}^2} = 11.9 \text{ ksi}$$

$$F_s = 0.4\,(36 \text{ ksi}) \times 1.33 = 19.2 \text{ ksi}$$

$$11.9 < 19.2$$

## Tension Through Lift Eye

$$A = 4[3.25 \times 1.0] + 2[4.25 \times 1.25] = 23.6 \text{ in}^2$$

$$f_t = \frac{280^k}{23.6 \text{ in}^2} = 11.9 \text{ ksi}$$

$$F_t = 0.6\,(36 \text{ ksi}) \times 1.33 = 28.7 \text{ ksi}$$

$$11.9 < 28.7$$

## Check Weld of Cheek Plates

$$\frac{A_E}{A_{Total}} = \frac{1.0}{3.25} = 0.31$$

$$P_{shear} = 0.31 \times 280^k = 86.8^k$$

$$\text{Circumference} = \pi(10) = 31.4''$$

$$\frac{P}{C} = \frac{86.8}{31.4} = 2.8^{k/in}$$

$$w = \frac{2.8}{11.2} = 0.25 \text{ in}$$

Use $\frac{3}{8}$" fillet weld on cheek plates.

**CREST OFFSHORE, INC.**

Sheet 2.54 of ____

By J. Talbot Client U.S. Navy Subject Miscellaneous Structures
Date 8-16-76 Job No. 27-771-98 Calculation Superstructure

## Check Plate Weld to Column

Force due to Moment,

$$S_w = \frac{d^2}{3} = \frac{900}{3} = 300 \text{ in}^2$$

$$f_m = \frac{M}{2S_w} = \frac{2040 \text{ in-k}}{2(300)} = 3.4 \text{ k/in}$$

Force due to Shear,

$$A_w = 4 \times 30 \text{ in} = 120 \text{ in}$$

$$f_s = \frac{P}{A_w} = \frac{280^k}{120 \text{ in}} = 2.3 \text{ k/in}$$

Total Force on Weld,

$$f = (f_m^2 + f_s^2)^{1/2} = (3.4 + 2.3^2)^{1/2} = 4.1 \text{ k/in}$$

$$w = \frac{4.1}{11.2} = 0.37 \text{ in.}$$

Use $\frac{1}{2}$" fillet weld for lug plate to column

# SECTION 3

# BOAT LANDING

## 3.1 INTRODUCTION

The boat landing structural framing presented herein is designed to fit each of the four platform structures. Component details, boat bumpers, grating and stairs associated with the boat landing are not included in this section. Structural steel weights and the surface area to be painted are provided however.

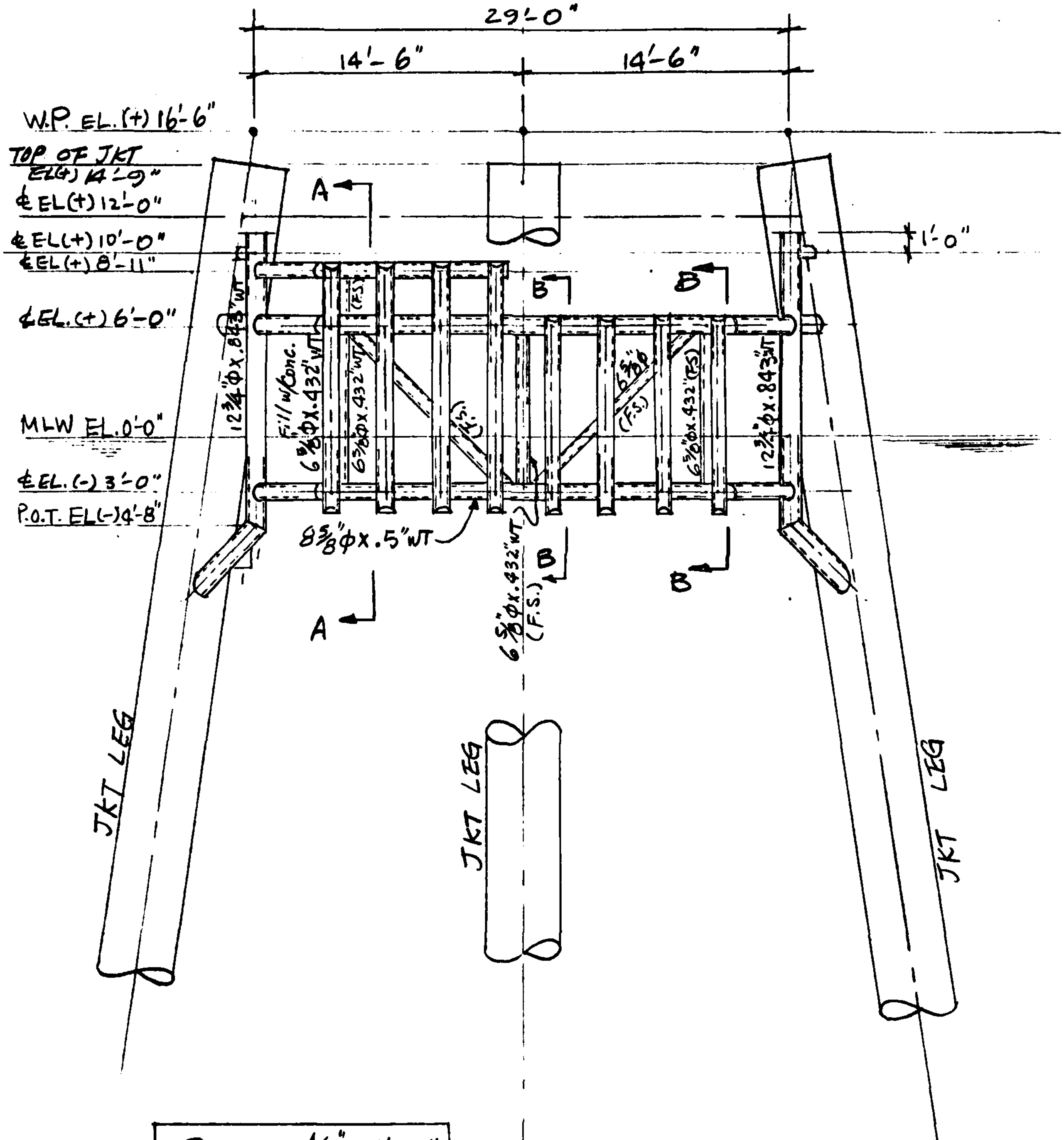
# 3.2 ELEVATIONS, PLANS AND SECTIONS

**CREST OFFSHORE, INC.**



By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 6-16-76 Job No. 27-771-98 Calculation Boat Landing

ELEVATION (Front View)



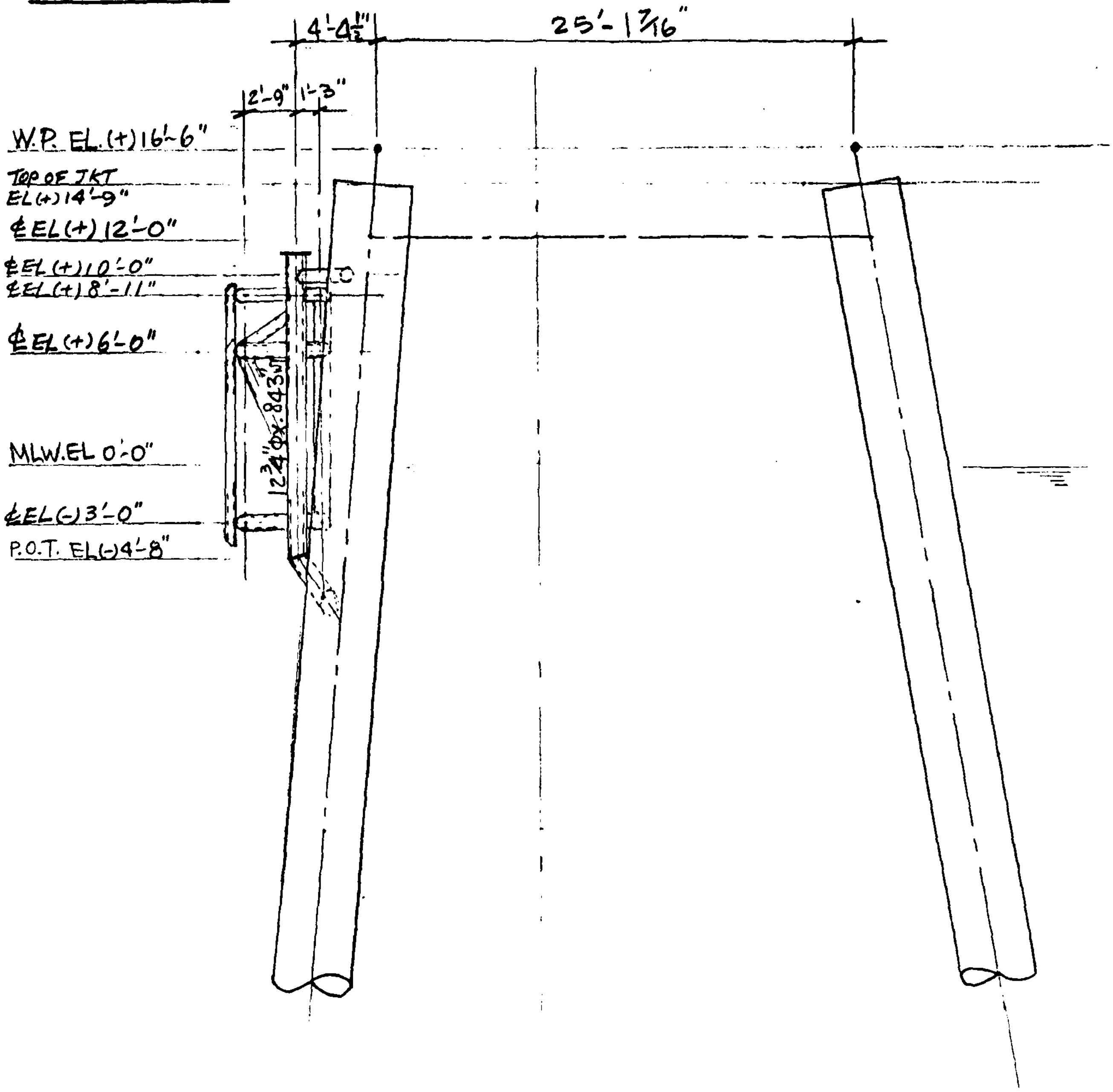

SCALE ⅛" = 1'-0"

# CREST OFFSHORE, INC.

Sheet 3.04 of 15

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 6-17-76 Job No. 27-771-98 Calculation Boat Landing

ELEVATION (Side View)

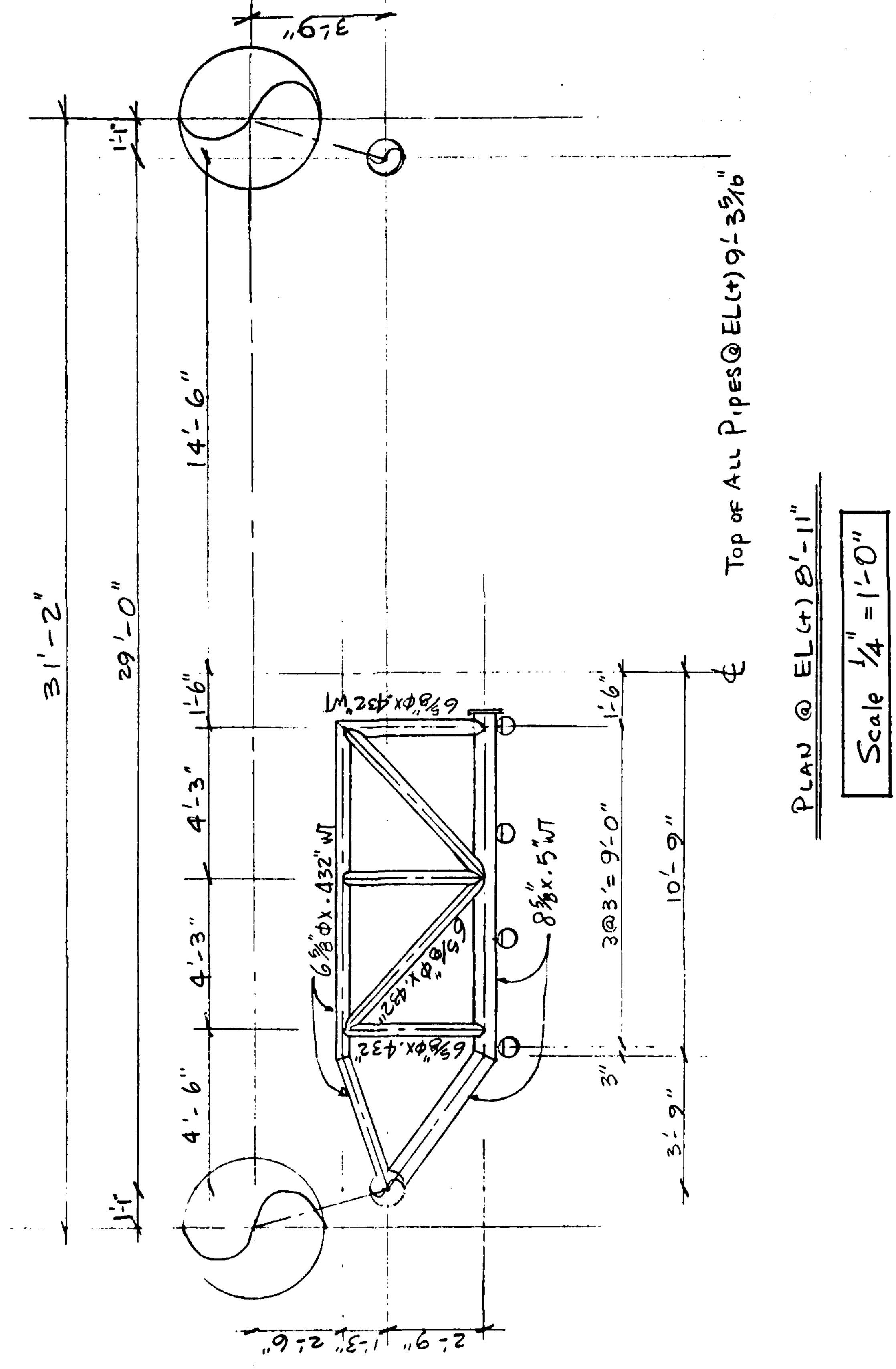



SCALE 1/8" = 1'-0"

**CREST OFFSHORE, INC.**

Sheet 3.05 of 15

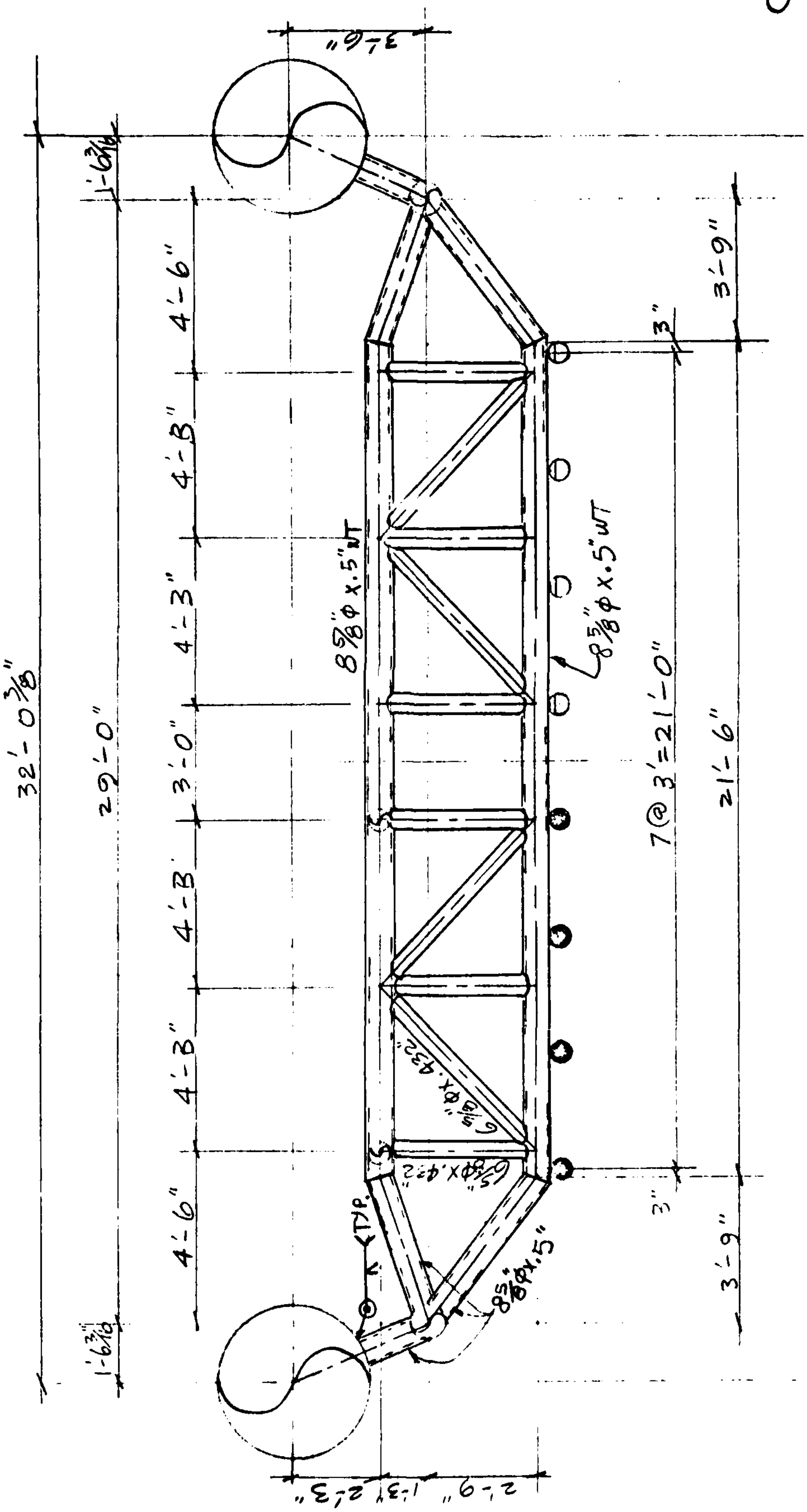
By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 6-17-76 Job No. 27-771-98 Calculation Boat Landing



**CREST OFFSHORE, INC.**

Sheet 3.06 of 15

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 6-16-76 Job No. 27-771-98 Calculation Boat Landing




Top of All Pipes Flush @ EL (+) 6'-4 3/16"

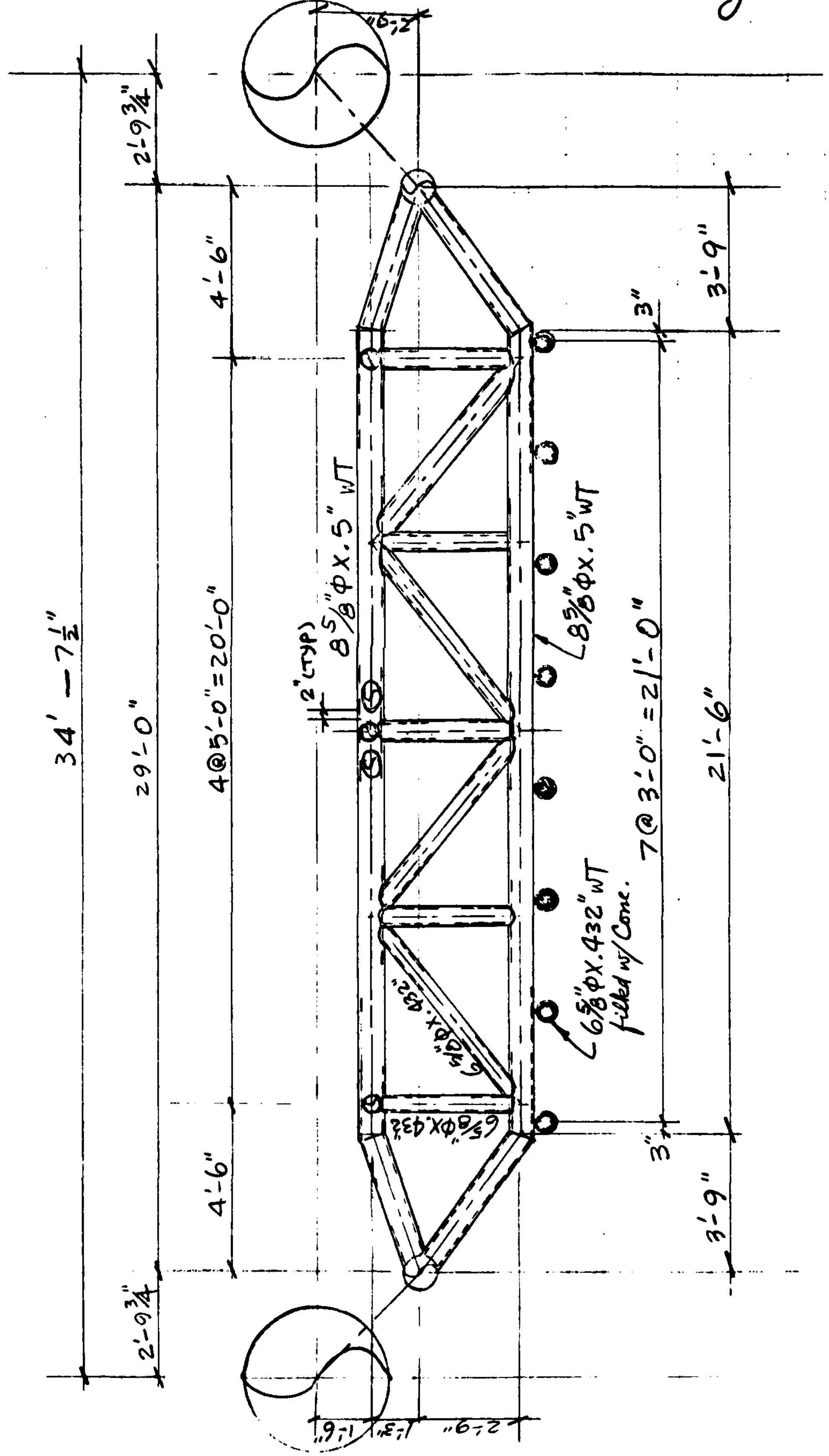
PLAN @ EL (+) 6'-0"

SCALE 1/4" = 1'-0"

**CREST OFFSHORE, INC.**

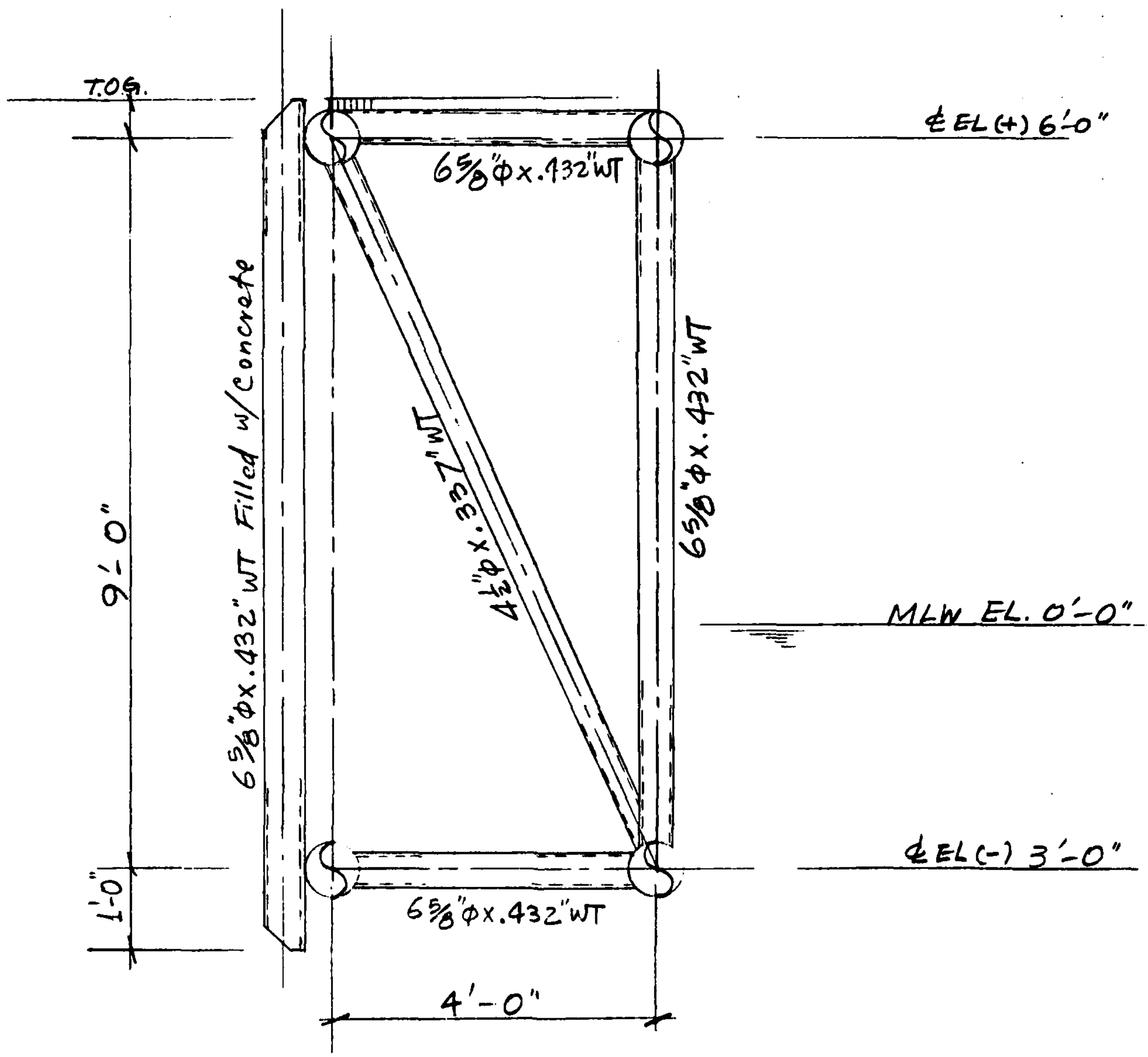
Sheet 3-07 of 15

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 6-16-76 Job No. 27-771-98 Calculation Boat Landing




PLAN @ EL.(-) 3'-0"

SCALE 1/4" = 1'-0"



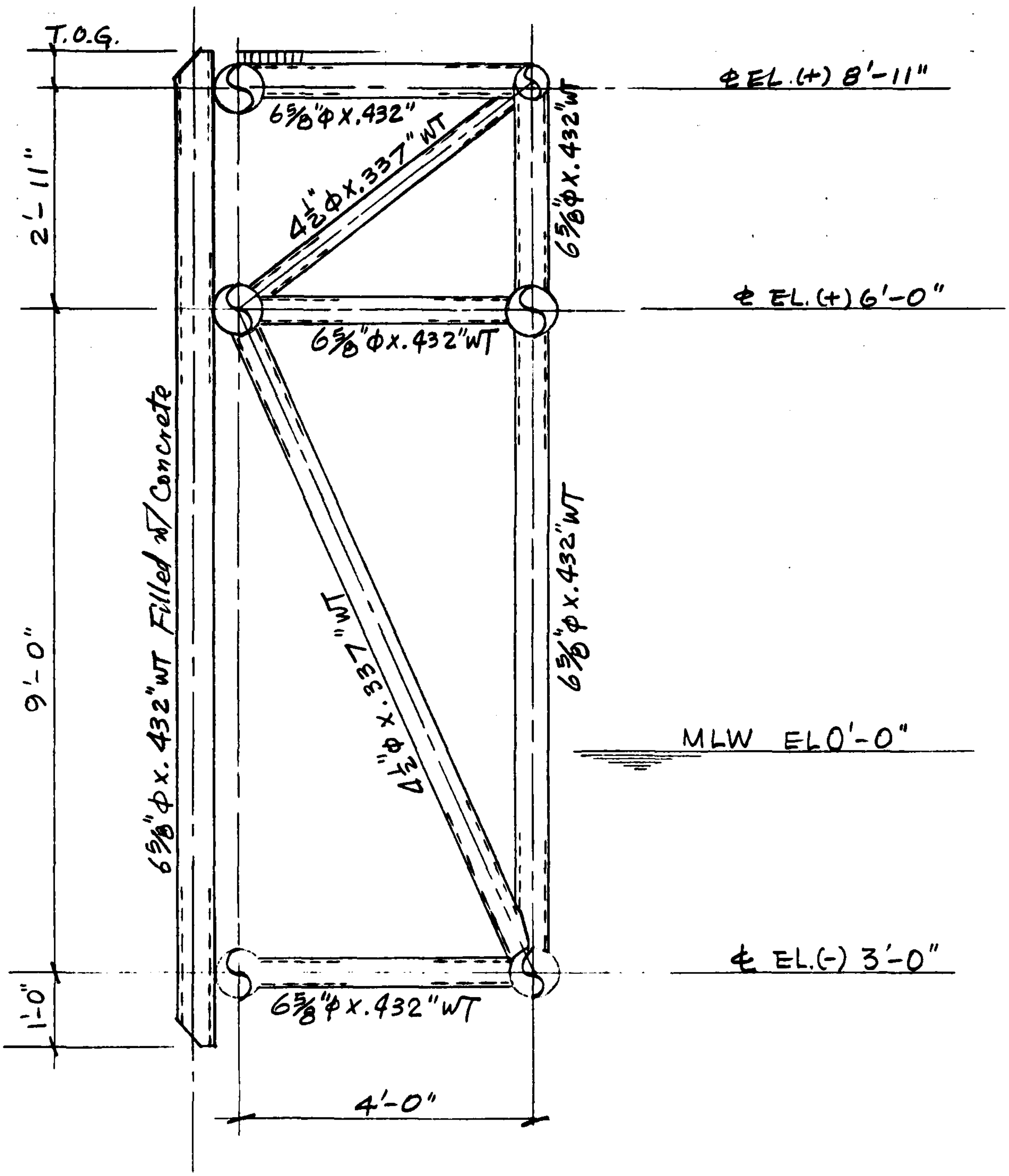

SECTION B

Scale 1/2" = 1'-0"

**CREST OFFSHORE, INC.**

Sheet 3.09 of 15

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 6-12-76 Job No. 27-771-98 Calculation Boat Landing




SECTION A

Scale ½"=1'-0"

**CREST OFFSHORE, INC.**

Sheet 3-10 of 15

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures

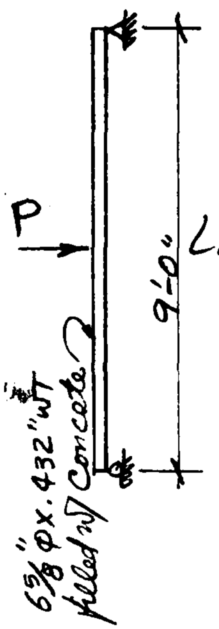
Date 6-17-76 Job No. 22-771-98 Calculation Boat Landing

## Check Member Strength

(1) $6\frac{5}{8}$" $\phi$ x .432" filled with concrete

Assume no composite action between steel wall and concrete filling.

$$I_x = 40.501 \text{ in}^4 \; ; \qquad S_x = 12.23 \text{ in}^3$$




Span = 9'-0"

$$M = \frac{PL}{4} \qquad M = \sigma S_x$$

Use $\sigma = 22$ ksi $\quad M = 22 \times 12.23 = 269.1$ "K

$= 22.42$ ft-kips

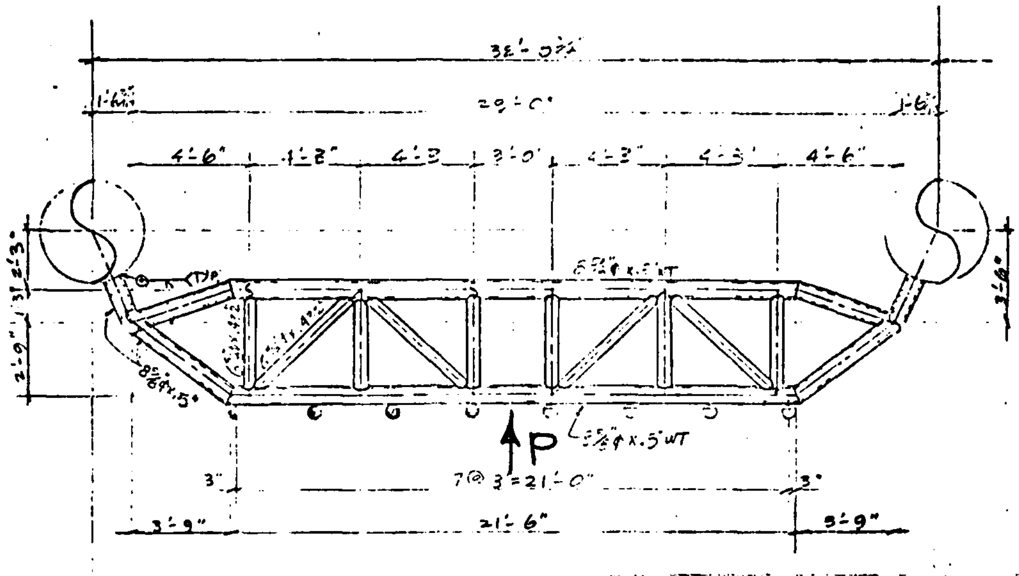
$$P = \frac{4M}{L} = \frac{4 \times 22.42}{9} = 10 \text{ kips}$$

Consider impact factor of 2.0

$$P = \frac{10}{2} = 5 \text{ kips}$$

** $6\frac{5}{8}$" $\phi$ fenders are able to resist a minimum of 5 kips impact force.

(2) Frame at EL.(+) 6'-0"




Moment of Inertia $= \Sigma Ad^2 + \Sigma I_o{}^2$

$8\frac{5}{8}"\phi \times .5"WT \qquad A = 12.76 \,\square" \quad ; \quad I_o = 105.74 \text{ in}^4$

$$I = 2\left[12.76 \times 24^2 + 105.74\right]$$

$$= 14{,}911 \text{ in}^4$$

$P = 10^{\text{ kips}}$ $(= 5^{\text{ kips}} \times 2^{\text{ Impact factor}})$

$$\sigma_b = \frac{Mc}{I} = \left[\frac{10 \times 21.5}{4} \times 12\right] \times \frac{28}{14{,}911}$$

$$= 1.21 \text{ ksi} \ll 22 \text{ ksi}$$

**CREST OFFSHORE, INC.**

Sheet 3.12 of 15

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 6-17-76 Job No. 27-771-98 Calculation Boat Landing

(3) Vertical Load Resistance at Jacket Leg Connections

| | | |
|---|---|---|
| Total Dead Weight | = | 22 kips |
| Live Load | = | 4 kips |
| | | 26 kips |

$$\text{shear at each connection} = \frac{26}{6} = 4.33 \text{ kips}$$

Full penetration field welds on $8\frac{5}{8}'' \times .5''$ WT pipe

effective shear area $\doteq$ 12.76 □"

$$\tau = \frac{4.33}{12.76} = 0.34 \text{ ksi}$$

**CREST OFFSHORE, INC.**



By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 6-12-76 Job No. 27-721-98 Calculation Boat Landing

## 3-3 DEAD WEIGHT OF BOAT LANDING

| MEMBER SIZE | MEMBER LENGTH | NO. REQUIRED | TOTAL LENGTH | UNIT WEIGHT | TOTAL WEIGHT |
|---|---|---|---|---|---|
| IN. x IN. | FT | | FT | LBS/FT | LBS |
| EL.(+) 8'-11" | | | | | |
| 8⅝"φ x .5"WT | 9.75 | 1 | 9.75 | 43.39 | 423.1 |
| | 4.00 | 1 | 4.00 | | 173.6 |
| | | | 13.75 | | 596.7 |
| 6⅝"φ x .432"WT | 9.50 | 1 | 9.50 | 28.57 | 271.4 |
| | 2.50 | 1 | 2.50 | | 71.4 |
| | 4.00 | 3 | 12.00 | | 342.8 |
| | 5.84 | 2 | 11.68 | | 333.7 |
| | | | 35.68 | | 1,019.3 |
| EL.(+) 6'-0" | | | | | |
| 8⅝"φ x .5"WT | 21.5 | 2 | 43.0 | 43.39 | 1,865.8 |
| | 4.0 | 2 | 8.0 | | 347.1 |
| | 3.5 | 2 | 7.0 | | 303.7 |
| | 1.5 | 2 | 3.0 | | 130.2 |
| | | | 61.0 | | 2,646.8 |
| 6⅝"φ x .432"WT | 4.0 | 6 | 24.0 | 28.57 | 685.7 |
| | 5.84 | 4 | 23.36 | | 667.4 |
| | | | 47.36 | | 1,353.1 |
| EL.(-) 3'-0" | | | | | |
| 8⅝"φ x .5"WT | 21.5 | 2 | 43.0 | 43.39 | 1,865.8 |
| | 4.0 | 2 | 8.0 | | 347.1 |
| | 3.5 | 2 | 7.0 | | 303.7 |
| | | | 58.0 | | 2,516.6 |

**CREST OFFSHORE, INC.**

Sheet 3-14 of 15

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 6-17-76 Job No. 27-771-98 Calculation Boat Landing

| MEMBER SIZE | MEMBER LENGTH | NO. REQUIRED | TOTAL LENGTH | UNIT WEIGHT | TOTAL WEIGHT |
|---|---|---|---|---|---|
| IN. X IN. | FT | | FT | LBS/FT | LBS |
| 6⅝"Φ x .432" WT | 4.0 | 5 | 20.0 | 28.57 | 571.4 |
| | 6.4 | 4 | 25.6 | | 731.4 |
| | | | 45.6 | | 1,302.8 |
| Verticals | | | | | |
| 12¾"Φ x .843" WT | 15.67 | 2 | 31.34 | 107.32 | 3,363.4 |
| | 5.0 | 2 | 10.0 | | 1,073.2 |
| | | | 41.34 | | 4,436.6 |
| 6⅝"Φ x .432" WT | 13.0 | 4 | 52.0 | 28.57 | 2,660.8 |
| Filled w/ Conc. | 10.0 | 4 | 40.0 | 22.60 | 2,046.8 |
| | | | 92.0 | (51.17) | 4,707.6 |
| 6⅝"Φ x .432" WT | 9.0 | 3 | 27.0 | 28.57 | 771.4 |
| | 3.0 | 2 | 6.0 | | 171.4 |
| | 13.45 | 2 | 26.9 | | 768.5 |
| | | | 59.9 | | 1,711.3 |
| 4½"Φ x .337" WT | 7.21 | 3 | 21.63 | 14.98 | 324.0 |
| | 5.0 | 1 | 5.00 | | 74.9 |
| | | | 26.63 | | 398.9 |
| Grating | 80 SQ.FT | | | 10.4 #/□' | 832.0 |
| | | | | | 21,521.7 # |
| | | | | | Say 22,000 # |

**CREST OFFSHORE, INC.**

Sheet 3.15 of 15

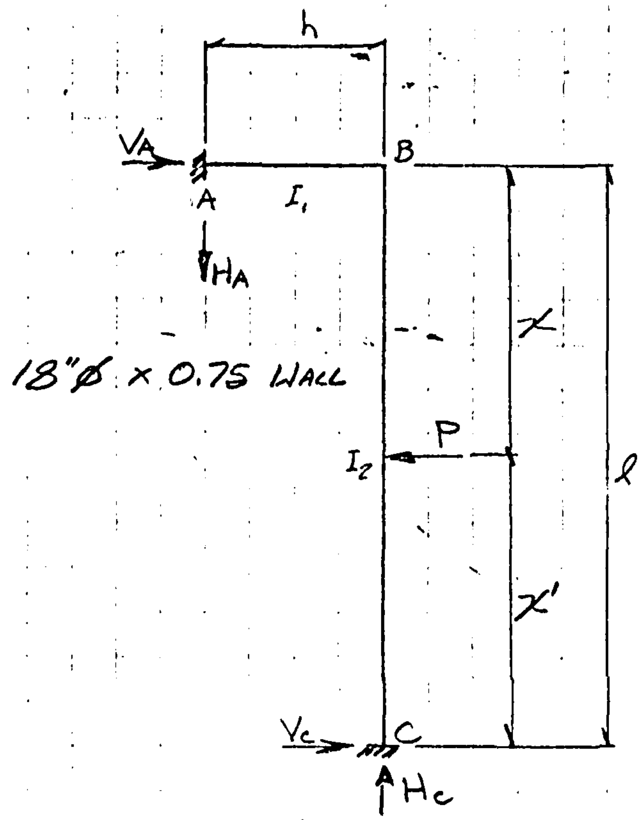
By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-16-76 Job No. 27-771-98 Calculation Boat Landing

## 3.4 PAINT AREA

| MEMBER SIZE | MEMBER LENGTH | SURFACE AREA | NO. REQUIRED | TOTAL AREA | NOTES |
|---|---|---|---|---|---|
| | FT | SQ. FT | | SQ. FT | |
| 8 5/8"φ X .5" WT | 13.75 | | | 31.0 | EL. (+) 8'-11" |
| 6 5/8"φ X .432" WT | 35.68 | | | 61.9 | |
| 8 5/8"φ X .5" WT | 61.0 | | | 137.7 | EL. (+) 6'-0" |
| 6 5/8"φ X .432" WT | 47.36 | | | 82.1 | |
| 8 5/8"φ X .5" WT | 58.0 | | | 131.0 | EL. (-) 3'-0" |
| 6 5/8"φ X .432" WT | 45.6 | | | 79.1 | |
| 12 3/4"φ X .843" WT | 41.34 | | | 138.0 | Verticals |
| 6 5/8"φ X .432" WT | 151.9 | | | 263.5 | |
| 4 1/2"φ X .337" WT | 26.63 | | | 31.4 | |
| Grating | | 80.0 | | 160.0 | |
| | | | | 1,115.7 | TOTAL |

## 3.5 Boat Fenders

## STIFFNESS ANALYNESS




$P = 100^k$
$\ell = 19.5 \times 12 = 234.0''$
$h = 4.59 \times 12 = 55.06''$
$I_1 = 1515$
$I_2 = 1515$

$k = \frac{h}{\ell} = \frac{55.06}{234.0} = 0.24$

$N = k + 1 = 1.24$

$\mathcal{L} = \mathcal{R} = \frac{3P\ell}{8} = 8775.0$

$\mathfrak{S}_r = \mathfrak{S}_\ell = \frac{P\ell}{2} = 11700.0$

$M_x^0 = \frac{P\ell}{4} = 5850.0$

$$M_C = -\frac{\mathcal{R}(3k+4) - 2\mathcal{L}}{6N} = -3203.59''^k$$

$$M_B = -\frac{2\mathcal{L} - \mathcal{R}}{3N} = -2367.83''^k$$

$$M_A = \frac{-M_B}{2} = -1183.9''^k$$

$$M_x = M_x^0 + \frac{x'}{\ell} M_B + \frac{x}{\ell} M_C = +2727.21''^k$$

$$V_A = \frac{\mathfrak{S}_r - M_B + M_C}{\ell} = 46.43^k$$

$$V_c = P - V_A = 53.57^k$$

$$H_A = H_c = \frac{3M_A}{h} = 64.51^k$$

**CREST OFFSHORE, INC.**

Sheet 3.17 of ____

By [signature] Client U.S. NAVY Subject MISCELLANEOUS STRUCTURE
Date 9-2-76 Job No. 27-771-98 Calculation BOAT FENDER ANALY.

## BEAM STRESS CHECK

MAX. MOMENT = $M_C$ = 3203.59$^{\text{IN-K}}$

$\sigma = \frac{M}{S} = \frac{3203.59}{168.3} = 19.03^{KSI} < 21.6$ ok

$F_b = 0.6 F_y = 0.6(36) = 21.6^{KSI}$

## CONCLUSION

18"Ø × 0.75" WALL WITH A STRESS OF 19.03$^{KSI}$ IS GOOD AND WILL WITH STAND 100$^{K}$ IMPACT LOAD APPLIED AT THE MID POINT OF THE FENDER.

# SECTION 4

# EQUIPMENT SUPPORT DETAILS

## 4.1 INTRODUCTION

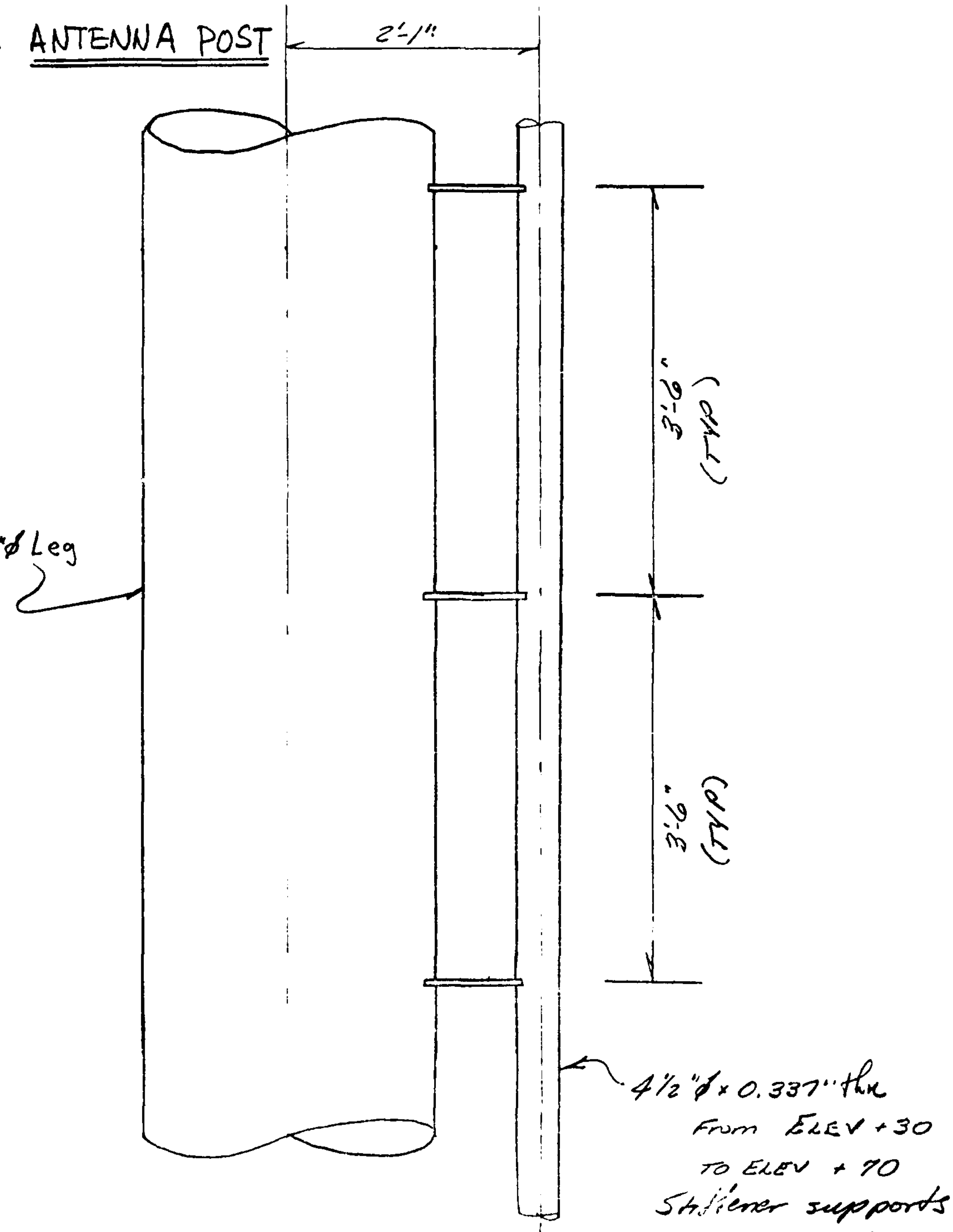
Support details for antenna post and solar panel framing are presented in this section.

**CREST OFFSHORE, INC.**

Sheet 4.02 of 14

By ESP Client U.S. Navy Subject Miscellaneous Structures
Date 6-1-76 Job No. 27-771-98 Calculation Antenna Post

## 4.2 ANTENNA POST



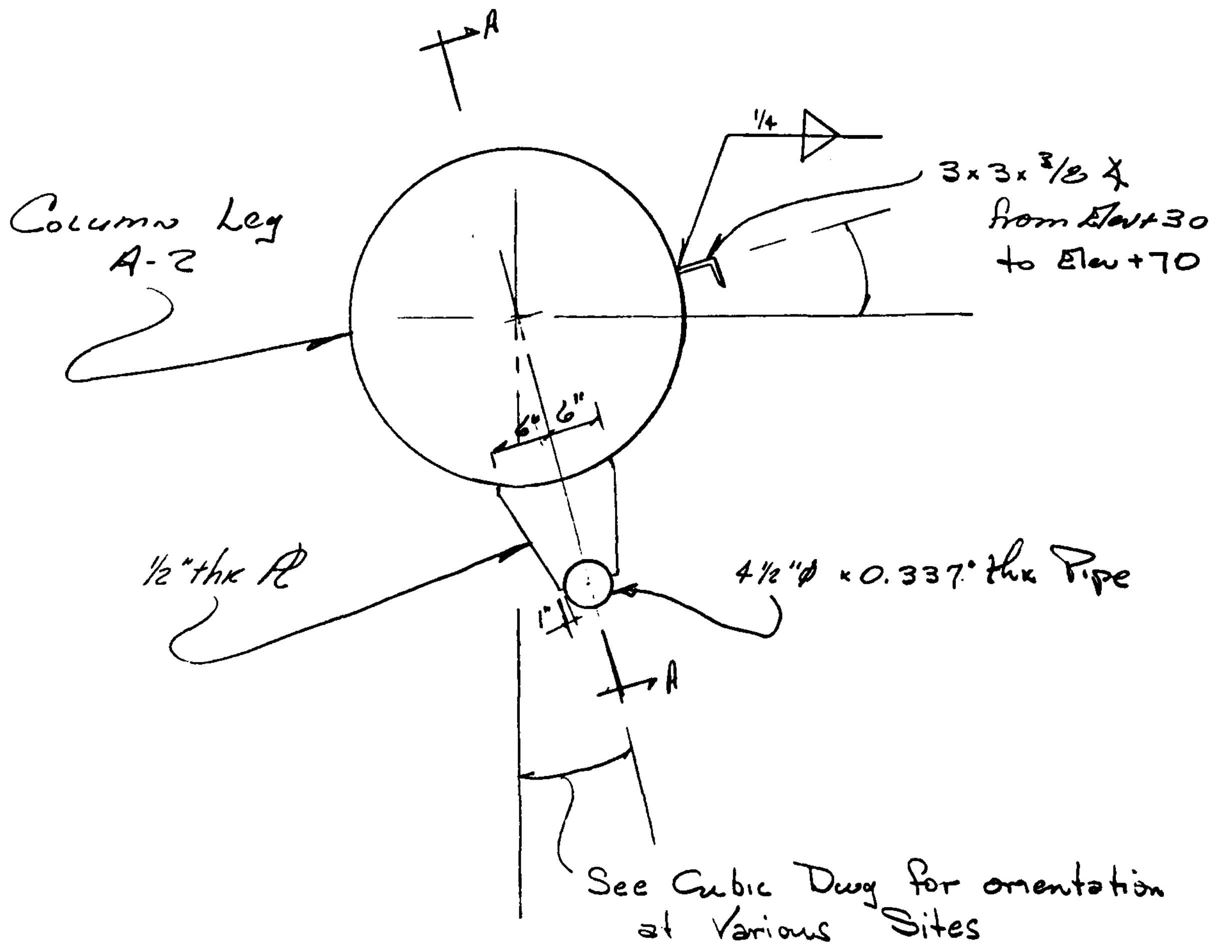

Put PL brace
3" below top &
3" above bottom of
End of Pipe - Cap
ends of pipe w/ ¼" PL

**CREST OFFSHORE, INC.**

Sheet 4.03 of 14

By ESP Client U.S. Navy Subject Miscellaneous Structures

Date 6-1-76 Job No. 27-771-98 Calculation Antenna Post

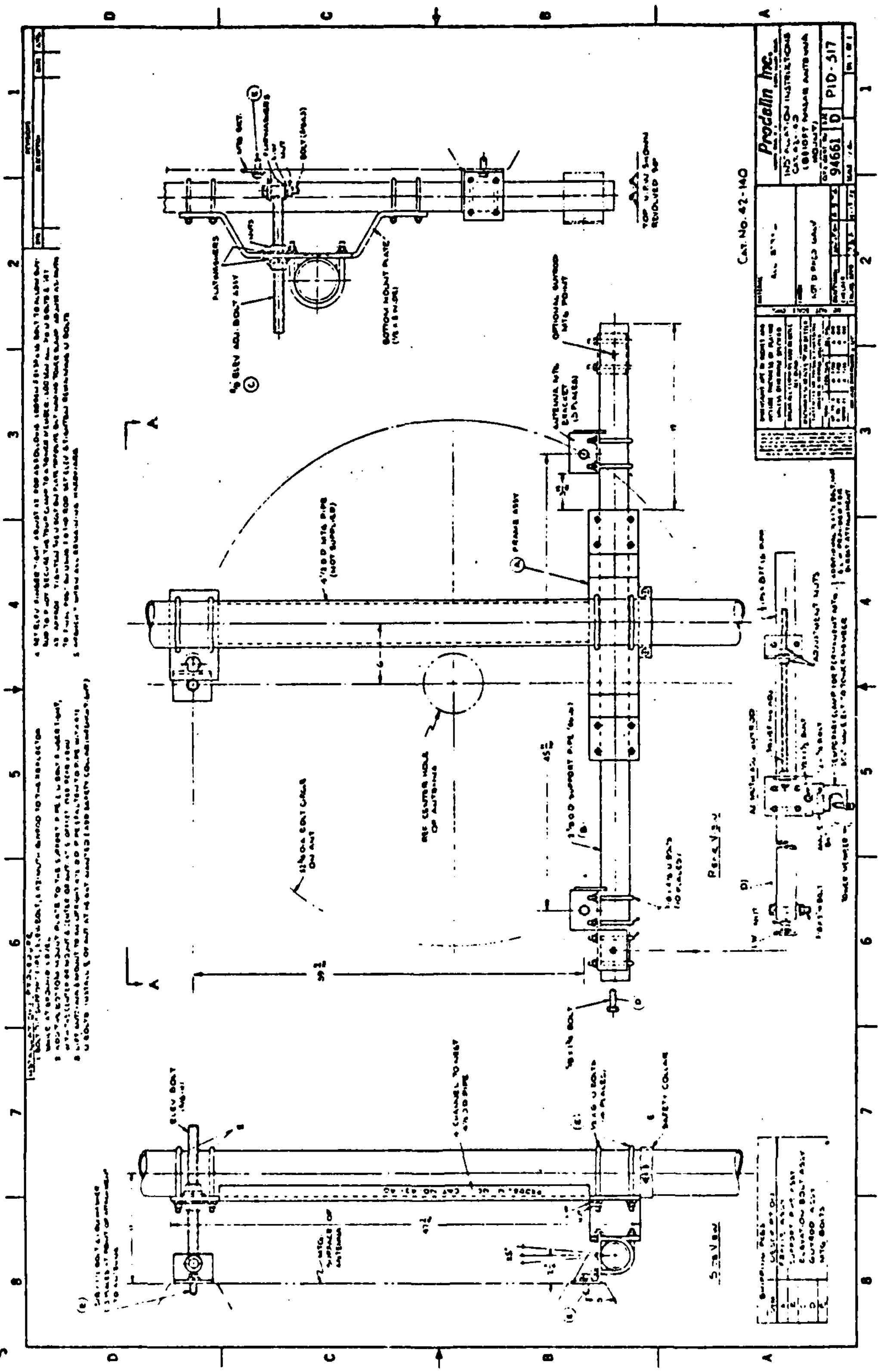


**CREST OFFSHORE, INC.**

Sheet 4.04 of 14

By ______ Client U.S. NAVY Subject Miscellaneous Structures

Date 7-15-76 Job No. 27-71L-98 Calculation Antenna Post



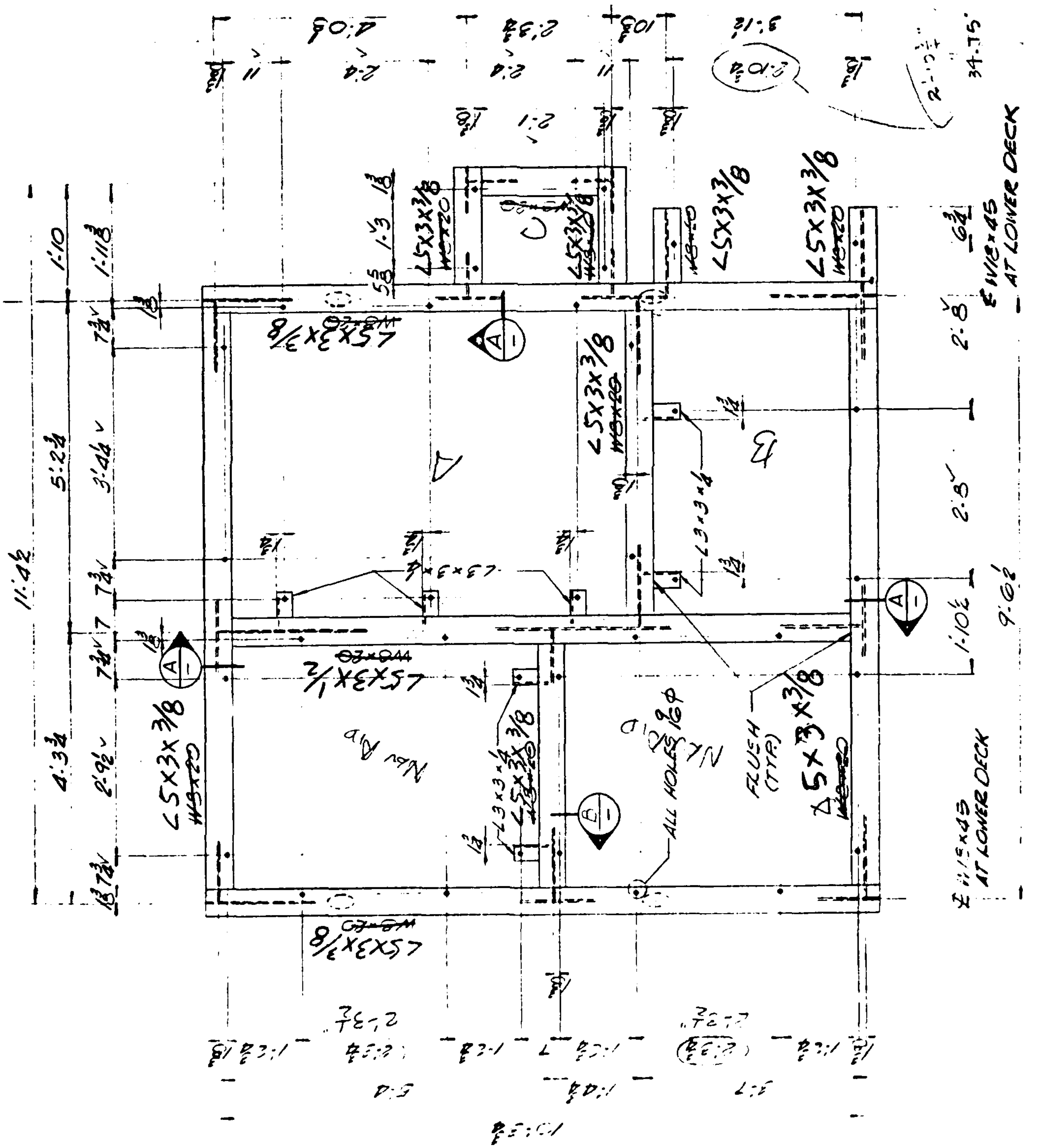

Sht 4 of 8 ord

**CREST OFFSHORE, INC.**

Sheet 4.05 of 14

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-21-76 Job No. 27-771-98 Calculation Solar Panel Support Details

## 4.3 SOLAR PANEL SUPPORT DETAILS



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By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-21-76 Job No. 27-771-98 Calculation Solar Panel Support Details

## Wind Forces

Ref.: Page 9.24, Report No. 27-771-92

APPENDIX C. THREE PILE CONCEPT CALCULATIONS

$$F = 0.00256\, C_s\, A\, C_H\, V_{30}^2$$

$F$ = force in lbs

$V_{30}$ = velocity @ EL.(+)30′ = 150 knots = 173 mph

$C_s$ = 1.5 for flat surfaces

= 1.0 for cylindrical surfaces

$A$ = projected area of surface (SQ.FT)

$C_H$ = height coefficient $= (H/30)^{2/7}$

Let $q_{30} = 0.00256\, C_s\, C_H\, V_{30}^2$

$$q_{30} = 0.00256 \times 1.5 \times (173)^2 = 115 \text{ psf}$$

@ EL(+) 64′-6″ $\left(60 + \frac{1}{2} \times 10.4 \cos 30° = 64.5'\right)$

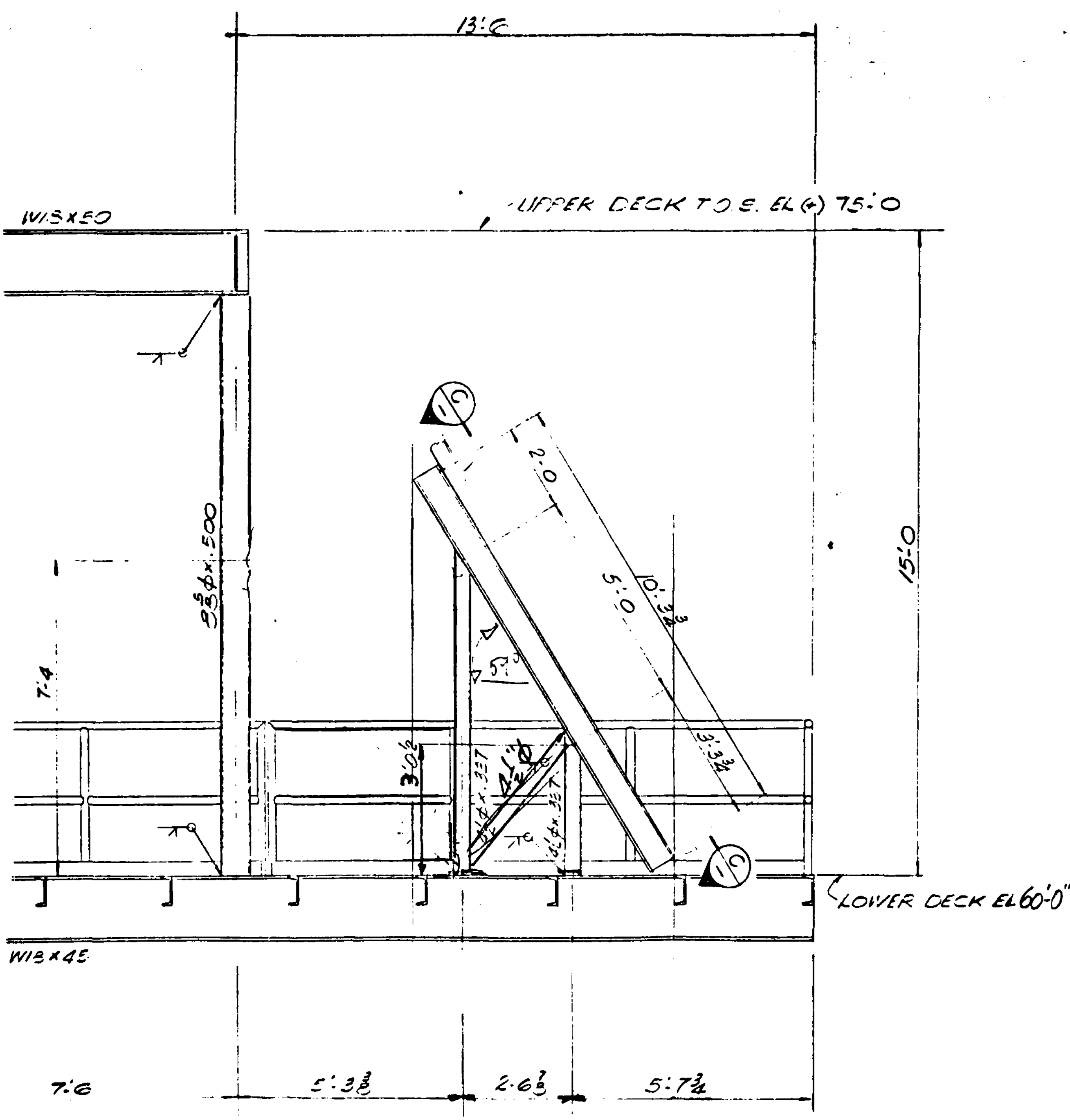
$$C_s = \left(\frac{64.5}{30}\right)^{2/7} = 1.244$$

$$q_{64.5} = 115 \times 1.244 = 143 \text{ psf}$$

**CREST OFFSHORE, INC.**

Sheet 4.07 of 14

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-21-76 Job No. 27-771-98 Calculation Solar Panel Support Details



Projected Area $A = 11.5 \times (10.5 \cos 30°)$

$= 104.6$ SQ. FT

Total Wind Force $F = 143 \times 104.6$

$= 14{,}958$ Lbs

Assuming that solar panel framings are flexible so that a uniformly distributed wind load may be transfered to the panel supports.

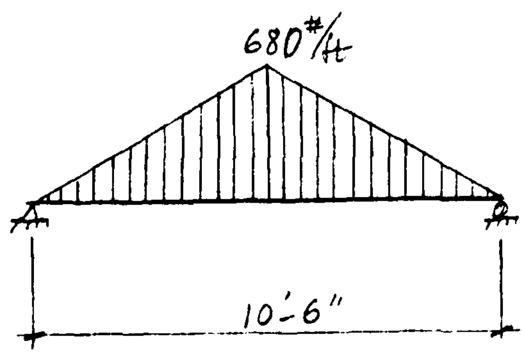
Ref. to wind area shown in Pg. 4.09

$A = \frac{1}{2} \times 9.5 \times (5.5 \cos 30°) = 22.6$ SQ. FT

Wind Force $= 143 \times 22.6 = 3{,}232$ Lbs

Triangular load at peak $3{,}232 = \frac{1}{2} w \times 9.5$

$w = 680$ #/ft




AISC 2-198

Case #3

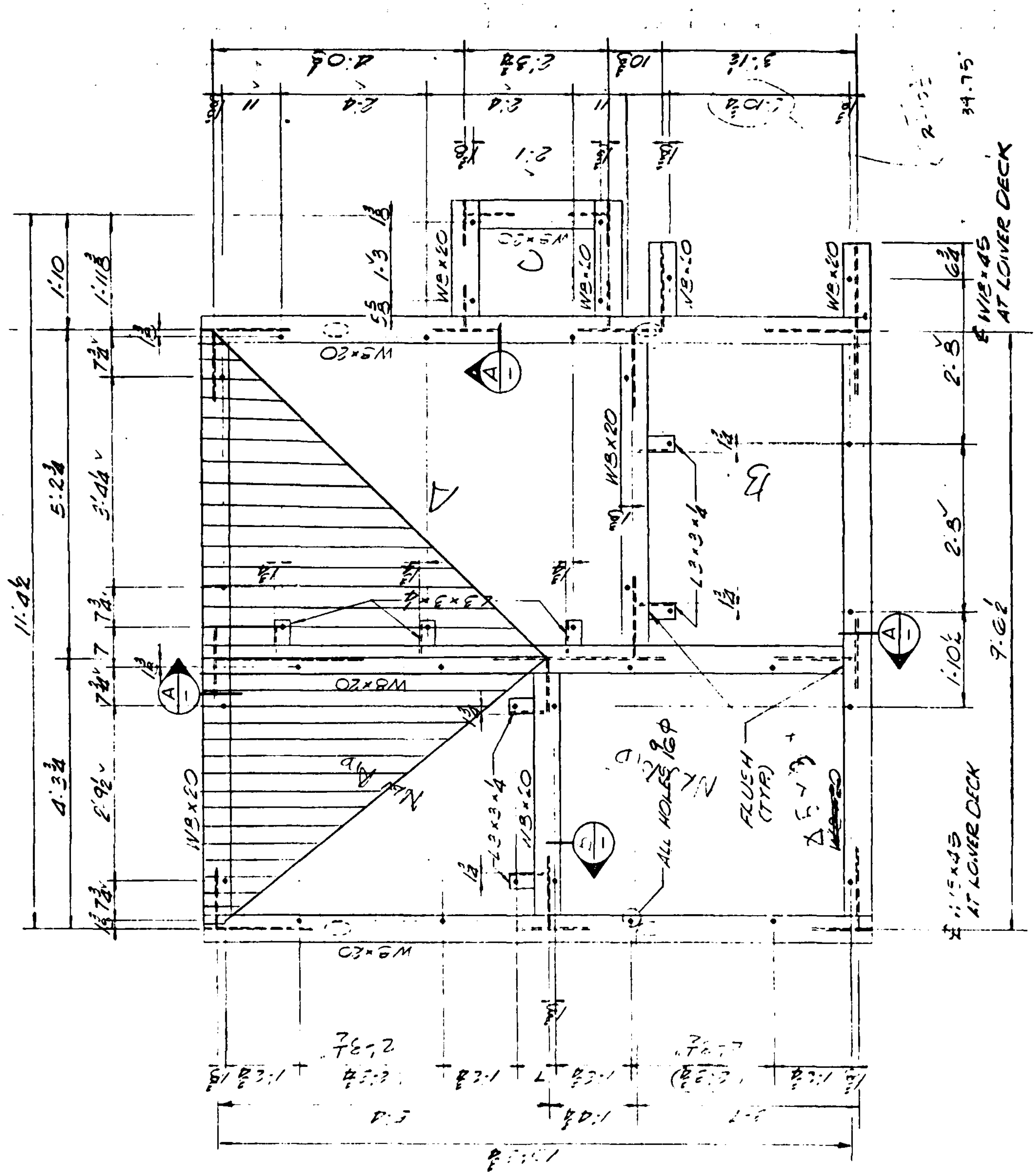
W = 3,232 #

**CREST OFFSHORE, INC.**

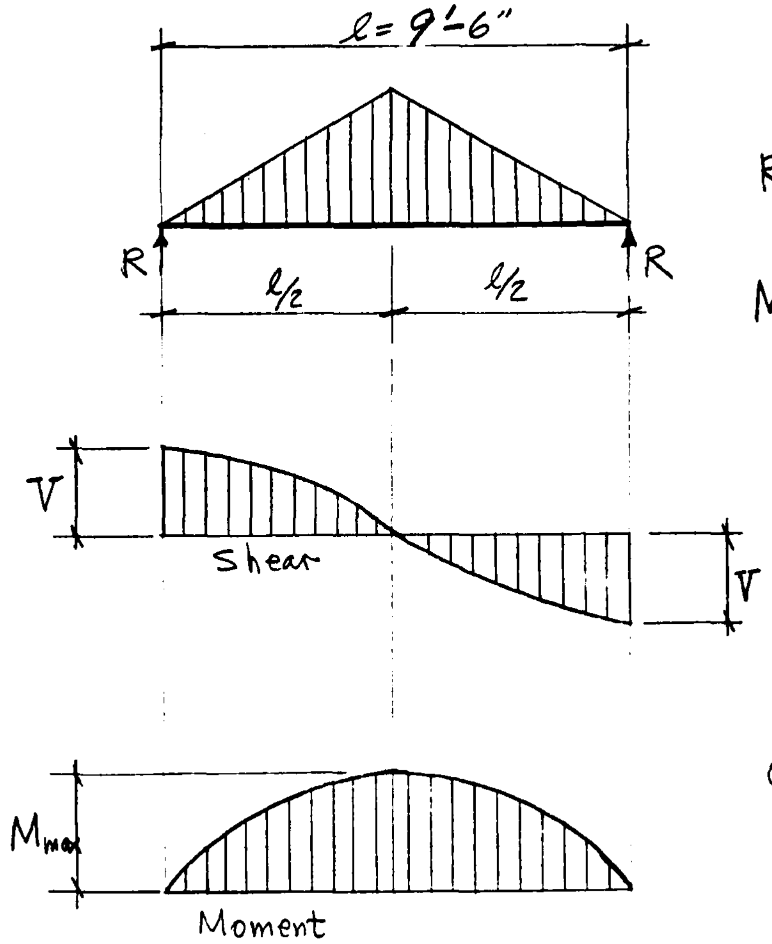
Sheet 4.09 of 14

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures

Date 7-22-76 Job No. 27-771-98 Calculation Solar Panel Support Details



By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-22-76 Job No. 27-771-98 Calculation Solar Panel Support Details




$R = V = \frac{W}{2} = 1{,}616$ #

$M_{max} = \frac{Wl}{6}$

$= \frac{3{,}232 \times 9.5}{6} \times \left(\frac{12}{1000}\right)$

$= 61.4$ "K

$\Delta_{max} = \frac{Wl^3}{60EI}$
(center)

Try ∠ 5 x 3 x 3/8 $S_x = 2.24$ in³

$I_x = 7.37$ in⁴

$\sigma_b = \frac{M}{S_x} = \frac{61.4}{2.24} = 27.4$ ksi

AISC
A36 Steel Allowable $\sigma_b = 22 \times 1.33 = 29.3$ ksi $> 27.4$ ksi

o.K.

$$\Delta_{max} = \frac{3.232 \times (9.5 \times 12)^3}{60 \times 30{,}000 \times 7.37} = 0.36''$$

---

Ref. to Wind area shown in Pg. 4.12

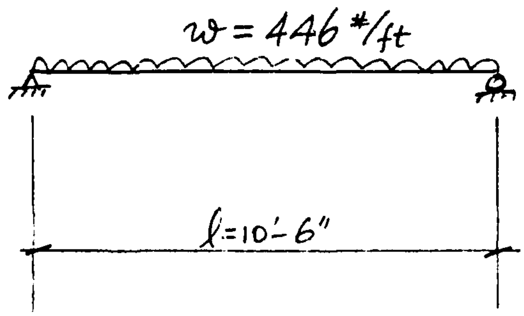
$$A = \frac{1}{2}(10.5 + 5.25) \times 2.2 + \frac{1}{2}(10.5 + 5.25) \times 2.6$$

$$= 37.8 \text{ SQ. FT}$$

$$\text{Total Wind Force} = 143 \times 37.8 \times \cos 30^\circ$$

$$= 4{,}681\ \#$$

$$\text{Equivalent uniform load} = \frac{4{,}681}{10.5} = 446\ \#/ft$$




$$M_{max} = \frac{wl^2}{8} = \frac{446 \times 10.5^2 \times 12}{8 \times 1000}$$

$$= 73.8\ ''^{K}$$

Try ∠ 5x3x½

$$S_x = 2.91\ in^3;\ I_x = 9.45\ in^4$$

$$\sigma_b = \frac{73.8}{2.91} = 25.4^{ksi} < 29.3^{ksi}\ \text{O.K.}$$

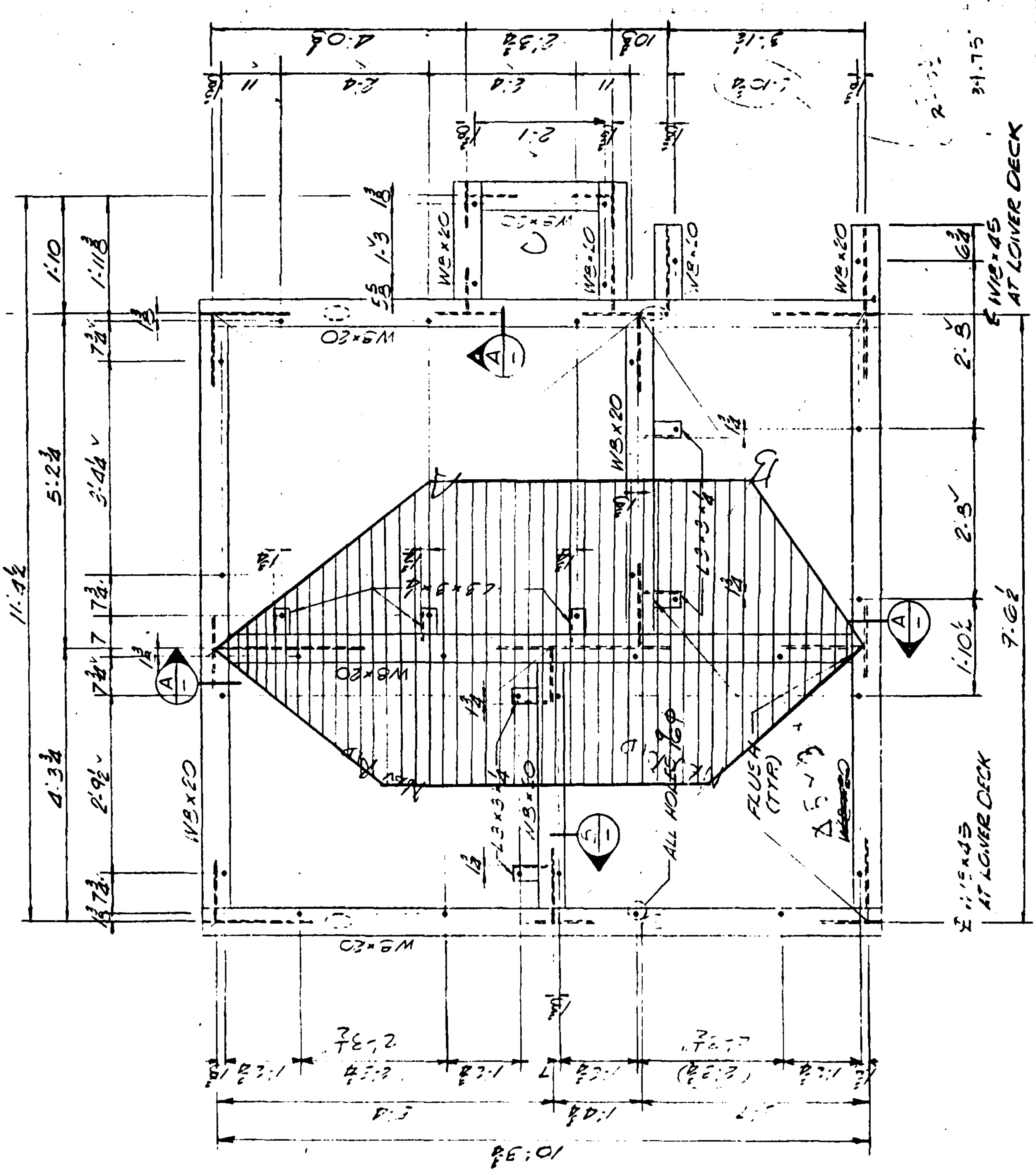
$$\Delta_{max} = \frac{5wl^4}{384EI} = \frac{5 \times .446 \times (10.5)^4 \times (12)^3}{384 \times 30{,}000 \times 9.45} = 0.43''$$

**CREST OFFSHORE, INC.**

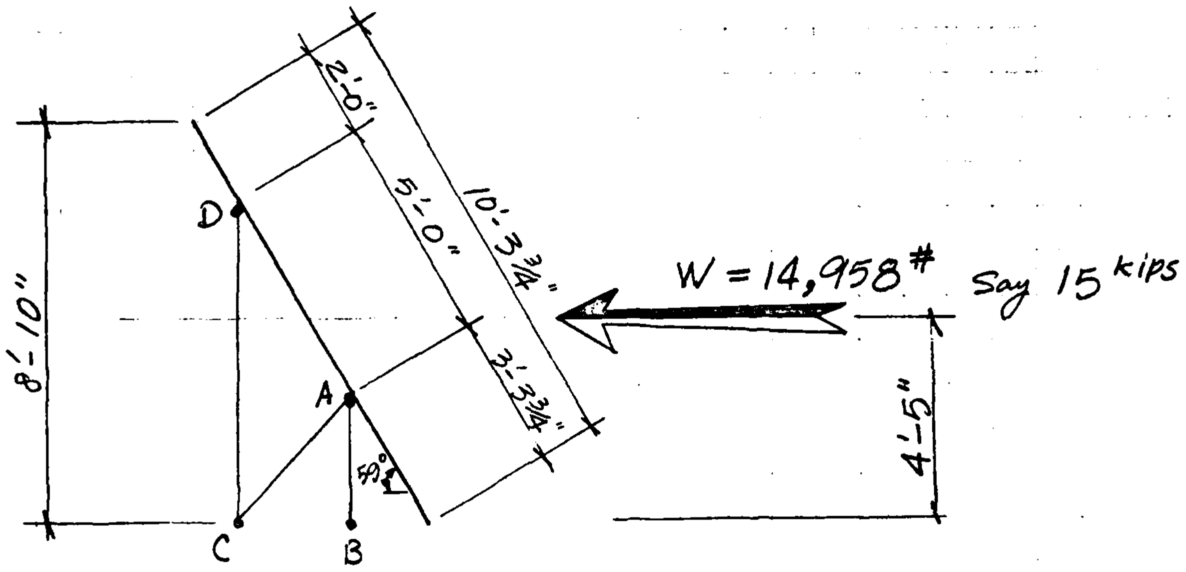
Sheet 4.12 of 14

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures

Date 7-22-76 Job No. 27-771-98 Calculation Solar Panel Support Details



By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-22-76 Job No. 27-771-98 Calculation Solar Panel Support Details




$$\Sigma M_A = 0 \qquad 14{,}958 \times (4.5 - 2.8) = (R_{CD} \times 5 \sin 31^\circ) \times 2$$

$$R_{CD} = \frac{14{,}958 \times 1.7}{2 \times 2.575} = 4{,}938\ \# \quad \text{(Comp.)}$$

$4\frac{1}{2}$" $\phi$ X .337" WT $\quad A = 4.41$ SQ. IN.

$$f_a = \frac{4.938}{4.41} = 1.12 \text{ ksi}$$

$$r = 1.477"$$

$$\frac{KL}{r} = \frac{1 \times 6.1 \times 12}{1.477} = 49.5$$

$$F_a = 18.40 \text{ ksi}$$

$$\frac{f_a}{F_a} = \frac{1.12}{18.40} = 0.06$$

$\Sigma M_c = 0 \qquad 14{,}958 \times 4.5 = 2 \times \left(R_{AB} \times 5 \sin 31°\right)$

$$R_{AB} = \frac{14{,}958 \times 4.5}{2 \times 2.575} = 13{,}070\,\# \text{ (Tens.)}$$

$4\frac{1}{2}''\phi \times .337''$ WT

$$f_a = \frac{13.07}{4.41} = 2.96 \text{ ksi} < 22 \text{ ksi} \quad \text{OK}$$

Joint A (Assuming DA carrys no force)

$$R_{AC} \cdot \frac{1}{\sqrt{2}} = R_{AB}$$

$$R_{AC} = 13.07 \times \sqrt{2} = 18.48 \text{ kips (Comp.)}$$

$4\frac{1}{2}''\phi \times .337''$ WT

$$f_a = \frac{18.48}{4.41} = 4.19 \text{ ksi} < 22 \text{ ksi} \quad \text{O.K.}$$

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